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ABSTRACT

This paper describes trends in and causes of minority and female representation among holders of advanced science and math degrees. The minority groups studied are Blacks, Hispanic Americans, American Indians, and Asian Americans, all of whom are compared with Whites. The degrees looked at include those in math, the computer sciences, physical sciences, biological sciences, engineering, and economics. Following the introduction, Section II assesses the current representation of minorities and women in post-secondary degrees in these fields, trends in that representation, and the extent to which underrepresentation is attributable to academic persistence/degree attainment as opposed to field choice at each degree level. Section III describes the talent pool from which the advanced degree holders come--when it first emerges during the educational process and how it changes over time. Section IV describes individual and institutional factors that produce the observed representational trends. Extensive tabular data is provided throughout the document. (CMG)

A SPECIAL REPORT
The Rockefeller Foundation

WHO WILL DO SCIENCE?

Trends, and their causes, in minority and female representation among holders of advanced degrees in science and mathematics.

Sue E. Berryman

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Minority and Female Attainment of Science and Mathematics Degrees: Trends and Causes

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CONTENTS

TABLES AND FIGURES

TABLES

FIGURES

PREFACE

This paper was prepared as a special report for the Social Science Division of The Rockefeller Foundation. It represents background material for the Foundation's efforts in broadening career opportunities in science-based careers available to minorities and women.

Dr. Sue Berryman is a member of the Behavioral Sciences Department of The Rand Corporation, although the views expressed in this paper are the author's own and not necessarily shared by The Rand Corporation or its research sponsors. The formal research team included Dr. Robert Bell, a statistician at The Rand Corporation and statistical consultant for the project; Diane Alexander, research assistant; Lincoln Boullion, programmer; and Lois Haigazian, who supervised the production of the paper. Their contributions are impressive; the project would not have been possible without them.

Dr. Kevin McCarthy and Dr. Lorraine McDonnell of The Rand Corporation added ideas and information, as did Dr. Lewis Solmon of UCLA. Several members of The Rockefeller Foundation made helpful comments as work progressed: among them Dr. Bruce Williams, Dr. Alberta Arthurs, and especially Dr. Phoebe Cottingham. Dr. Cottingham not only monitored the project, but also was a most supportive colleague to all concerned with this project.

Bernard E. Anderson
Director for Social Sciences

EXECUTIVE SUMMARY

This report describes the representation of women and five racial and ethnic groups among B.A., M.A., and Ph.D. degrees, both total degrees and degrees granted in the quantitatively based disciplines.* It also assesses the causes of such representation.

CURRENT REPRESENTATION

Relative to whites, Asian-Americans are overrepresented substantially among quantitative fields at all degree levels; blacks, Hispanics, and American Indians are underrepresented, especially at the Ph.D. level. Blacks are the most severely underrepresented among quantitative degrees at all degree levels. For example, in 1979, a randomly selected Asian-American was 17 times more likely to earn a quantitative Ph.D. than a randomly selected black from the appropriate age group, and a randomly selected white was 7 times as likely to do so.

Women are also underrepresented among quantitative degrees at all degree levels compared with men. For example, in 1980, a randomly selected man in the appropriate age group was three times more likely than a randomly selected woman to receive a quantitative Ph.D.

LOOKING AT TRENDS

Policy inferences to be drawn from representational data depend on representational *trends*. Minorities and women may be changing their representation among quantitative degrees at rates which, projected forward, would gain them proportionate representation in the 1980s. In that case, the decision to invest resources in correcting representational imbalances depends on whether the projection is plausible and the projected time to secure proportionate representation is acceptable.

Current enrollment data suggest that in the early 1980s blacks and

*The quantitative disciplines include the biological sciences, physical sciences, computer sciences, mathematics, and engineering.

Asian-Americans may show an increase in their shares of B.A. degrees greater than increases in their shares of the age-relevant population. Graduate enrollment data, however, give us no reason to expect much change in the early 1980s in any subgroup's share of graduate degrees.

Degree data for the last five years show that, relative to their shares of the age-relevant population, an increasing fraction of associate degrees are going to whites; decreasing portions, to minority groups. Whites evidence a slight decline in their shares of total B.A., M.A., and Ph.D. degrees, but no real change in quantitative B.A., M.A., and Ph.D. degrees. Asian-Americans show gains in their shares of total, as well as of quantitative, B.A., M.A., and Ph.D. degrees, even when we take into account increases in their shares of the age-relevant population. Blacks, Hispanics, and American Indians show little variation across time once changes in their age-relevant population shares are considered.

The trends for women are strong and positive. In the last decade, women earned an increasing percent of the degrees conferred at *every* level--associate, B.A., M.A., Ph.D., and professional. They are still underrepresented among Ph.D. and professional degrees, but if their rates of increase continue, by 1990 the percentage of Ph.D. degrees and professional degrees earned by women should approximately equal their representation in the age-relevant population. Women also show increases in *quantitative* degrees at each degree level, but growth in their shares of these degrees was much smaller than that for total degrees.

LOSSES FROM THE EDUCATIONAL PIPELINE AND FIELD CHOICES

At any given degree level, a group's share of quantitative degrees reflects two factors: persistence in the pipeline and field choice. To assess persistence, we traced the progress of cohorts through the educational pipeline. All subgroups lose members as they progress through the system; the issue is whether, at particular points in the process, a subgroup loses more or fewer than all other groups.

We found that underrepresentation of blacks, Hispanics, American Indians, and women among quantitative Ph.D. degrees is partly attribut-

able to their underrepresentation at the Ph.D. level itself. Interventions that aid retention in the educational process should therefore increase the representation of these groups among quantitative Ph.D.'s. However, the groups have different dropout patterns, indicating dissimilar needs.

For blacks, the losses are dispersed across the pipeline. For Hispanics, they are concentrated earlier: at high school graduation and college entry. For American Indians, they occur at least between college entry and the B.A. degree. If we had adequate data for this subgroup, we probably would also find disproportionately high losses at high school graduation and college entry. However, this subgroup does *not* show disproportionately high losses after the B.A. degree. For women, the losses are concentrated at the end of the pipeline: at the Ph.D. level.

When we examine field choices, we find that field choices also contribute to blacks' underrepresentation among quantitative B.A., M.A., and Ph.D. degrees. Blacks lose "field" ground just as they lose attainment ground: at several points in the process. At the B.A. level, the percent choosing quantitative fields is 60 percent of the national average; at the M.A. level, 40 percent; and at the Ph.D. level, 33 percent.

At the B.A. level, Hispanics' underrepresentation is attributable primarily to higher losses from the pipeline, not to field choices. Although field choices contribute to their underrepresentation at the M.A. level, disproportionately high attrition prior to the M.A. has more effect. Both pipeline attrition and field choices account for their underrepresentation at the Ph.D. level.

For the American Indians, higher pipeline losses, not field choices, cause their underrepresentation among quantitative B.A. and M.A. degrees. At the Ph.D. level, both factors account for their underrepresentation.

Although higher persistence during the educational process partly explains the overrepresentation of Asian-Americans among quantitative B.A., M.A., and Ph.D. degrees, their field choices are the driving force. Relative to whites, they choose quantitative fields at the rate of 2 to

1 at the B.A. level, 3 to 1 at the M.A. level, and 2 to 1 at the Ph.D. level. For example, in 1980, 60 percent of the Asian-American Ph.D. graduates earned their degrees in quantitative fields, relative to 30 percent of white Ph.D. graduates.

The field choices for women are startling. The increased percents of women in quantitative fields at *all* degree levels are entirely attributable to their greater representation at the degree levels themselves, *not to changes in their field choices*. Unless women begin to change their field preferences, further increases in their shares of quantitative degrees will depend on an increasing percent of women at each degree level. It is not clear that we can expect major percent increases at the lower degree levels.

SCIENTIFIC TALENT POOL: EMERGENCE AND CHANGE

To increase a subgroup's representation among quantitative degrees, policymakers have two choices. They can try to increase the group's share of the initial mathematical/scientific talent pool by more than any increase in its attrition from it, or try to reduce the group's attrition from the pool by more than any decrease in its share of the initial pool. In either case, policymakers need to know *when* action can be taken most effectively.

We find that the scientific/mathematical pool from which quantitative Ph.D. graduates ultimately derive first appears in elementary school. It emerges strongly before the 9th grade and is essentially complete by the 12th. The pool appears to reach its maximum size prior to senior high school and subsequently declines in size through graduate school.

Before the 9th grade, membership in the pool is defined more by quantitative interests than by skills. Children whose career interests require college differ in their substantive interests but not in their mathematical, verbal, and scientific skills. However, by the 12th grade, membership is defined both by mathematical/scientific interests and by significantly higher mathematical achievements. This distinction continues through graduate school, those planning a quantitative graduate

degree having higher quantitative skills than those planning a nonquantitative degree.

Although the talent pool seems to reach its maximum size before high school, migration into the pool continues to occur during grades 9 through 12. However, *after high school migration is almost entirely out of, not into, the pool.* As a consequence, those who obtain quantitative doctorates or have quantitatively oriented careers a decade after high school come overwhelmingly from the group who in grade 12 had scientific and mathematical career interests and high mathematical achievement scores.

These results have two major policy implications. First, strategies to increase the size of the initial scientific/mathematical pool of minorities and women should be targeted before and during high school. Second, strategies to decrease attrition from the pool can be targeted at any point in the process, since attrition from the pipeline and from quantitative fields occurs at all points.

THE CAUSES OF UNDERREPRESENTATION

We assessed the effects of subgroup characteristics and educational institutions on women's and minorities' underrepresentation in quantitative fields. When we look at the subgroups themselves, we can say: (1) more about women and blacks than about the other subgroups; (2) more about choices made in the high school senior year and in college than about those made before grade 10 or after college; and (3) more about capabilities and preferences than about information.

Gender Effects

For women the pattern is clear:

- Although 9th-grade boys and girls do not differ significantly in average mathematical achievement, the girls like mathematics less and are less apt to choose mathematically related careers than the boys.
- Preferences for quantitative careers strongly affect participation in high school elective mathematics courses.

- Differences between boys and girls in their 12th-grade mathematics achievement scores are primarily attributable to differences in their participation in elective mathematics courses.
- Mathematics ability and career interests strongly predict men's and women's choices of a science major in college.
- Mathematics ability, career interests, and the initial choice of a science major strongly predict persistence in a science major.
- High mathematical achievement at grade 12 predicts realization of grade 12 quantitative career plans by age 29.
- Those who had not planned a quantitative career at grade 12 and switched into a quantitative career by age 29 had high mathematical achievement at grade 12.

The key for women seems to be familiar motivational factors that shift girls' interests away from sex atypical careers and the high school mathematical sequence associated with quantitative postsecondary training. During adolescence, individuals are under simultaneous pressures to resolve sexual identities, form career preferences, and invest in any high school training required to pursue their preferences. Scientific career interests and investments in high school mathematics are consistent with the development of masculine, but not feminine, identities.

Although we do not know what effects foundation-stimulated interventions might have on preferences, strong preparation in high school mathematics preserves the options of entering a college science major and a postcollege quantitative career. Currently, the high school tradition of offering more advanced mathematics as electives interacts with women's lesser interests in mathematically related activities to foreclose these options to them.

Racial and Ethnic Effects

Analysis shows that the causes of minority underrepresentation are different from women's. Since the literature contains little information

on any minority group other than blacks, we conducted limited, exploratory analysis of survey data on full-time, first-time college freshmen of 1981. The data base had adequate samples of whites, blacks, American Indians, Chicanos, Puerto Ricans, and Asian-Americans. Our purpose was to assess causes of variations in choice of quantitative college majors. The causal possibilities that we examined included racial and ethnic origin, being second rather than first-generation college, scholastic ability, educational plans, and chai..teristics of the postsecondary institution at which the student was enrolled.

Our major interest was in assessing the effect of parental education, defined as the highest educational level attained by either parent. Parental education is frequently one component of measures of family socioeconomic status (SES). However, we were interested in it not as some partial measure of family SES, but as an indicator of whether the student was first or second-generation college. Information on the dynamics of the scientific/mathematical pool and on the causes of women's underrepresentation identify early college tracking and early orientation toward quantitative careers and training as important precursors of college entry and choice of a quantitative major.

In light of these precursors, we hypothesized that being at least second-generation college might be key to equalizing disciplinary choices among the racial and ethnic subgroups. Our reasoning was as follows:

1. *Early college tracking*. Parents with at least some college are more likely to assume that their children will attend college, and the children of such parents are accordingly more likely to assume early in their schooling that they will go to college.

2. *Required pre-collegiate training*. Parents with college know more about the early training investment that children must make to enter college and to pursue career interests, especially scientific/mathematical interests. Precollegiate students plan their education far less than school requirements, parents, and teachers plan it for them.

3. *Quantitative career options*. Second-generation college students are more likely to have grown up with the wider occupational

horizons available to the white collar mainstream. Movement from socially marginal positions, whether lower-class white or minority group, into the mainstream *appears* to occur via a limited set of occupations. Groups have varied in the nature of their "tickets out." (For example, the Irish used public-sector jobs, such as the police forces; Jews, entertainment, business, and the professions.) If the "tickets out" for a particular group do not happen to include quantitative occupations, the generation that makes the move will show up less in these occupations--or in training for these occupations. First-generation college students are more likely to be the generation that moves into the white collar mainstream; second-generation college students, to come from families that have already made this move. Thus, second-generation college students should have grown up with the wider set of career options associated with the mainstream position secured by their ancestors.

The data confirmed our reasoning. Being second-generation college not only increases, but also *equalizes*, choice of quantitative majors across the white, black, American Indian, Chicano, and Puerto Rican subgroups. When we disaggregate "first generation" and "second generation" college into six levels of parental education, we find that the equalization among non-Asian-American subgroups occurs when parental education shifts from no college to *any* college. Parental education does not affect college major choice of Asian-American freshmen. Although we had not expected parental education to *equalize* Asian-American and white freshman major choices, we had not predicted that Asian-American choices would be insensitive to variations in parental education.

The analyses show that parental education affects choice of a quantitative major through its effects on high school performance and postsecondary educational plans. However, our exploratory analyses did not tell us if parental education has an effect on the choice of college major in addition to its effects on these intervening factors. If it does, the success of policies to increase minority representation among quantitative majors could be limited by parental educational attainments. Even if parental education does not have an independent effect,

the success of policies targeted on the intervening factors still depends on how much these factors can be changed independent of changes in parental education.

The different non-Asian-American minorities seem to behave similarly with regard to choice of college major. As their families assimilate into the white collar mainstream, indicated by the presence of at least one parent with college, they behave like white college freshmen. However, the Asian-Americans do not behave either like other minority groups or like whites. They choose quantitative majors at double the white rates, and their choices are insensitive to variations in parental education. Each level of parental education translates into higher high school grades and postsecondary educational expectations than for the other freshmen groups. Each level of high school performance and expected educational attainment translates into higher rates of choosing quantitative majors.

Other analyses of the causes of blacks' choices of science majors are consistent with our results for blacks and the other non-Asian-American minority groups. However, these analyses also assess the retention of blacks in quantitative majors. They find that obtaining a quantitative B.A. degree or being enrolled in a quantitative major four years after college entry is primarily a function of quantitative choice at college entry.

The nature of the causes of women's and minorities' underrepresentation implies that structural changes already underway in the society should gradually increase their representation among quantitative doctorates. As the society decreasingly defines achievement by women and social approval of them as conflicting, as the association between masculinity and "hard" science careers breaks down, and as families recognize the economic need for daughters to plan careers, we should see more girls choosing careers that require quantitative training. We should also see them make these choices in time to take the necessary high school mathematics.

As minorities move into the white collar mainstream, their educational attainment and quantitative career choices should increase.

Passage into the mainstream seems to be occurring fairly rapidly, at least for families with longer residence in the United States. For example, by 1989, black adults of ages to have children in college (35-44 years old) will have *halved* the difference in college attendance that existed between black and white 35 to 44 year olds in 1969.

Institutional Effects

The literature indicates that differences among educational institutions produce differences in student outcomes, but that these effects are limited. Many apparent institutional effects are in fact attributable to differences in the students that various schools attract. For example, our analyses found that members of diverse racial and ethnic groups attending the same kind of college (e.g., two-year colleges) were more similar in their choices of a quantitative major than members of the same racial and ethnic group attending different kinds of colleges.

The nature of the quantitative Ph.D. educational process suggests that the earlier years of this process are the most crucial. This raises the question of how elementary and secondary schools might affect girls' and minorities' quantitative interests and skills. Our schools control the amount of time that students spend on different subjects, including high school graduation requirements. As studies show, time-on-task does affect how much students learn; the quality of that time does affect their involvement in the subject; standards do affect how hard they work and, in high school, what courses they take.

In general, the public schools do not seem to serve any students particularly well in mathematics and science. Between the third and eighth grades, the schools do not maintain, let alone increase, students' positive attitudes toward science. Most school districts require only one year of high school mathematics and one year of science to graduate, and at least half of the nation's high schools do not offer fourth-year mathematics or advanced science courses. Not surprisingly, only a third of our high school graduates leave school with three years of mathematics; only a fifth with three years of science.

Ironically, our attempts to give students more curricular choice in

high school have resulted in reducing their postsecondary training and career options. Simply increasing mathematics and science graduation requirements--as some states have already done--would preserve them, although such a move would exacerbate the shortage of qualified mathematics and science teachers already faced by the nation's high schools.

The issues for postsecondary schools are effects on college entry, ultimate educational attainment, and field of training. For minorities, the most crucial institutional issue associated with college entry would seem to be finances. The literature does not answer the specific question of whether lack of aid prevents college entry (and retention) of those students who would otherwise obtain a quantitative B.A. degree. However, those who initially select and ultimately obtain degrees in quantitative fields represent the most able students in every racial and ethnic subgroup. The literature does suggest that able, needy students are the *most* likely to seek out and receive financial help.

There is little careful literature on the effects of postsecondary institutions on educational attainment and field of training. What studies are available suggest that two-year colleges and predominantly black two-year and four-year colleges reduce persistence in college. Parents, students, taxpayers, and policymakers constantly raise questions about issues such as these. They seem important enough to warrant the intellectual investments required to determine how different kinds of postsecondary institutions affect the quality, the amount, and the fields of our students' training.

I. *INTRODUCTION*

This paper describes trends in and causes of minority and female representation among quantitatively-based doctorates. These doctorates are defined to include degrees in mathematics, the computer sciences, physical sciences, biological sciences, engineering, and economics. Our immediate purposes are to answer the following questions.

- Do women and minorities have the same access as white males to those careers that require quantitatively-based doctorates?
- Do trends in enrollments and degrees suggest future changes in female and minority access to these careers?
- When does the quantitative talent pool begin to form, and what are the migration rates in and out of this pool during the educational process? What do these dynamics imply for the timing of strategies to increase women's and minorities' membership in the pool?
- What causes the underrepresentation of different subgroups, and how do they differ by subgroup?
- What do these causes imply for strategies to increase the representation of the different subgroups?

In the process of answering these questions the paper sheds light on two other issues of social concern. Do women and minorities have access to quantitatively-based careers that require degrees *less* than the doctorate? And what are the trends in the nation's production of technical and quantitative personnel at all postsecondary degree levels?

This paper is the result of a three-month project that relied on published statistics, specific and limited analyses of existing data bases, and published analyses. It is organized into three sections. Section II assesses the current representation of minorities and women among the quantitatively-based doctorates, trends in that representation, and the extent to which underrepresentation is attributable to

degree attainment as opposed to field choice at each degree level. Section III describes the talent pool from which the quantitative doctorates come: when it first emerges during the educational process and how it changes across time. Section IV describes the individual and institutional factors that produce the observed representational trends.

II. THE REPRESENTATION OF MINORITIES AND WOMEN AMONG QUANTITATIVELY-BASED DOCTORATES

This section describes minorities' and women's representation among the quantitatively-based postsecondary degrees (B.A., M.A., Ph.D., and professional degrees). Within the limits of the available data, it answers four questions:

1. What is the representation of minorities and women today among the quantitatively-based degrees?

2. Does a projection of postsecondary enrollment and degree trends imply changes in their representation in the near future, either at particular degree levels or among the quantitative disciplines?

3. For subgroups underrepresented among quantitatively-based Ph.D.'s, where in the educational pipeline does the underrepresentation begin to occur?

4. At each degree level, how much of the underrepresentation among quantitative degrees is attributable to the subgroup's field choice, as opposed to underrepresentation at the degree level itself?

CURRENT REPRESENTATION OF MINORITIES AND WOMEN

Tables 1-7 show the current representation of minorities and women at different degree levels and among the quantitative disciplines at each degree level. Table 1 shows the percent of each kind of degree that went to each racial and ethnic group in 1978/79. Thus, for example, blacks earned 6.6 percent of all B.A. degrees awarded in 1978/79. This table shows that blacks, Hispanics, and American Indians had larger shares of the associate degrees awarded in 1978/79 than of any other degrees conferred in that year--B.A., M.A., Ph.D., or professional degrees.

Table 2 gives us a basis for judging whether a group's share at each degree level is representative. It shows us the ratio of the group's degree share to its share of the age-relevant population.[1] A

[1] We defined different age-relevant populations for each degree level: 21 year olds for the associate degree, 22 year olds for the B.A. degree, 25-29 year olds for M.A. and professional degrees, and 30-34

Table 1

1978/79 REPRESENTATION OF RACIAL AND ETHNIC GROUPS BY DEGREE LEVEL[a]

Racial and Ethnic Group	Degree Level				
	Associate Degree	B.A.	M.A.	Ph.D.	Professional Degree
Total	100.0	100.0	100.0	100.0	100.0
Whites	82.3	88.1	88.5	90.8	91.2
Blacks	9.1	6.6	6.9	4.4	4.2
Hispanics	5.1	3.3	2.0	1.6	2.5
American Indians	0.6	0.4	0.4	0.4	0.3
Asian-Americans	1.9	1.7	2.0	2.8	1.8

[a]See Tables 9-13.

Table 2

1978/79 REPRESENTATION RELATIVE TO REPRESENTATION IN THE AGE-RELEVANT POPULATION BY DEGREE LEVEL AND RACIAL AND ETHNIC GROUP[a]

Racial and Ethnic Group	Degree Level				
	Associate Degree	B.A.	M.A.	Ph.D.	Professional Degree
Whites	1.04	1.11	1.10	1.11	1.14
Blacks	0.70	0.51	0.58	0.41	0.35
Hispanics	0.86	0.62	0.36	0.31	0.45
American Indians	0.86	0.57	0.66	0.66	0.50
Asian-Americans	1.27	1.13	1.05	1.33	0.95

[a]Source: Tables 1, 17-21.

ratio of 1.00 for a given degree level implies that the group has a degree share equal to its population share. For example, the median age for attaining the B.A. is 22 years. In 1979, 12.9 percent of the 22 year olds were black, but only 6.6 percent of the B.A. degrees awarded in that year went to blacks, yielding a ratio of B.A. degrees to population of 0.51. Relative to their shares of the age-relevant populations, blacks, Hispanics, and American Indians are *under*represented at *all* degree levels, although least underrepresented at the associate level. Whites and Asian-Americans are overrepresented at all degree levels.

Table 3 shows for each degree level each group's share of the *quantitatively-based* degrees at that level. For example, in 1978/79

Table 3

1978/79 REPRESENTATION OF RACIAL AND ETHNIC GROUPS IN QUANTITATIVELY-BASED FIELDS[a] BY DEGREE LEVEL[b]

Racial and Ethnic Group	Degree Level			
	B.A.	M.A.	Ph.D.	Professional Degrees
Total	100.0	100.0	100.0	100.0
Whites	89.8	90.2	[illegible]	90.0
Blacks	4.1	2.5	1.7	4.1
Hispanics	2.9	1.6	1.1	2.6
American Indians	0.3	0.3	0.2	0.3
Asian-Americans	2.9	5.3	5.7	3.0

[a] Quantitatively-based fields for the B.A., M.A., and Ph.D. are defined to include the physical sciences, mathematics, computer sciences, biological sciences, engineering, and economics. For professional degrees the fields are biologically- or physically-based and defined to include medicine, dentistry, optometry, osteopathy, podiatry, veterinary medicine, and pharmacy.

[b] Source: Tables 10-13.

year olds for the Ph.D. degree. These ages or age groups represent or encompass the median ages at which the particular degree is awarded. For example, the median age for the Ph.D. degree in 1978/79 was 32 years. Population percents for whites are always for non-Hispanic whites.

whites obtained almost 90 percent of all quantitatively-based B.A. degrees. Black, Hispanic, and American Indian shares steadily decline from the B.A. to M.A. to the Ph.D. levels. White and Asian-American shares steadily increase.

Table 4 shows whether a subgroup's share of the quantitatively-based degrees at each degree level is equal to its share of the total degrees at that level. Again, a ratio of 1.00 implies equality of the two shares. These ratios eliminate variations among subgroups in their shares of the total degrees at each level. Relative to their shares of B.A., M.A., and Ph.D. degrees, blacks, Hispanics, and American Indians were underrepresented among the quantitatively-based degrees at each level. Their shares of the biologically- or physically-based professional degrees were about equal to their shares of these degrees in total.

At each degree level whites had about the same proportion of the

Table 4

1978/79 REPRESENTATION IN QUANTITATIVELY-BASED FIELDS[a] RELATIVE TO REPRESENTATION IN TOTAL DEGREES BY DEGREE LEVEL AND RACIAL AND ETHNIC GROUP[b]

Racial and Ethnic Group	Degree Level			
	B.A.	M.A.	Ph.D.	Professional Degrees
Whites	1.02	1.02	1.01	0.99
Blacks	0.62	0.36	0.39	0.98
Hispanics	0.88	0.80	0.69	1.04
American Indians	0.75	0.75	0.50	1.00
Asian-Americans	1.71	2.65	2.04	1.67

[a]Quantitatively-based fields for the B.A., M.A., and Ph.D. are defined to include the physical sciences, mathematics, computer sciences, biological sciences, engineering, and economics. For professional degrees the fields are biologically- or physically-based and defined to include medicine, dentistry, optometry, osteopathy, podiatry, veterinary medicine, and pharmacy.

[b]Source: Tables 1 and 3.

quantitatively-based degrees as of the total degrees at that level. At the M.A. and Ph.D. levels, Asian-American shares of the quantitatively-based degrees were at least double their shares of total M.A. and Ph.D. degrees.

Table 5

1978/79 REPRESENTATION IN QUANTITATIVELY-BASED FIELDS[a] RELATIVE TO REPRESENTATION IN AGE-RELEVANT POPULATION BY DEGREE LEVEL AND RACIAL AND ETHNIC GROUP[b]

Racial and Ethnic Group	Degree Level			
	B.A.	M.A.	Ph.D.	Professional Degrees
Whites	1.13	1.12	1.12	1.12
Blacks	0.32	0.21	0.16	0.35
Hispanics	0.55	0.29	0.21	0.47
American Indians	0.43	0.50	0.33	0.50
Asian-Americans	1.93	2.79	2.71	1.58

[a] Quantitatively-based fields for the B.A., M.A., and Ph.D. are defined to include the physical sciences, mathematics, computer sciences, biological sciences, engineering, and economics. For professional degrees the fields are biologically- or physically-based and defined to include medicine, dentistry, optometry, osteopathy, podiatry, veterinary medicine, and pharmacy.

[b] Source: Table 3, [illegible].

Table 5 shows for each degree level a subgroup's share of the quantitatively-based degrees relative to its share of the age-relevant population. Again, a ratio of 1.00 indicates proportional representation. Whites and Asian-Americans are overrepresented at each degree level, especially the latter group. Blacks, Hispanics, and American Indians are substantially underrepresented at all degree levels; blacks are most underrepresented; and the black and Hispanic shares decrease

from the B.A. to the M.A. to the Ph.D. For example, in 1978/79, relative to a randomly selected black from the appropriate age group,

- a randomly selected white was 3.5 times as likely to have received a quantitatively-based B.A., over 5 times as likely to have received a quantitatively-based M.A., and 7 times as likely to have received a quantitatively-based Ph.D.
- a randomly selected Asian-American was 6 times as likely to have received a quantitatively-based B.A., 13 times as likely to have received a quantitatively-based M.A., and 17 times as likely to have received a quantitatively-based Ph.D.

Table 6

1979/80 PERCENT FEMALE BY DEGREE LEVEL[a]

Degree Level	Percent Female	Ratio of Percent Female by Degree Level to Percent Female of Age-Relevant Population
High School Degree	51	1.04
Associate Degree[b]	54	1.09
B.A.	49	0.99
M.A.	49	0.98
Ph.D.	30	0.59
Professional Degree	27	0.54

[a]Source: Tables 14-16, 22.

[b]The data for this degree level are for 1978/79, not 1979/80. Later data are not yet published.

Table 6 displays the same information for females as Tables 1 and 2 showed for the racial and ethnic groups. In 1979/80 women got about half of all degrees awarded at each degree level except at the Ph.D. and professional degree levels. Relative to their shares of the age-relevant populations, they were slightly overrepresented at the high school and

associate degree levels, equally represented at the B.A. and M.A. levels, and underrepresented at the Ph.D. and professional degree levels. A randomly selected male was over twice as likely to have received a Ph.D. or a professional degree in 1978/80 as a randomly selected female of the age-relevant group.

Table 7 addresses the issue of quantitative degrees for females, showing the same information as Tables 3-5 showed for the racial and ethnic groups. Column 1 of Table 7 shows that from the B.A. to the Ph.D. degree, a declining percent of the quantitatively-based degrees go

Table 7

1978/79 PERCENT FEMALE IN QUANTITATIVELY-BASED FIELDS[a] BY DEGREE LEVEL[b]

Degree Level	Percent Female in Quantitatively-Based Fields	Ratio of Percent Female in Quantitatively-Based Fields to Percent Female of Total Degrees	Ratio of Percent Female in Quantitatively-Based Fields to Percent Female of Age-Relevant Population
B.A.	25	0.51	0.50
M.A.	18	0.37	0.36
Ph.D.	15	0.50	0.30
Professional Degree	25	0.93	0.50

[a]Quantitatively-based fields for the B.A., M.A., and Ph.D. are defined to include the physical sciences, mathematics, computer sciences, biological sciences, engineering, and economics. For professional degrees the fields are biologically- or physically-based and defined to include medicine, dentistry, optometry, osteopathy, podiatry, veterinary medicine and pharmacy.

[b]Source: Tables 6, 15-19, 22.

to females. Thus, women receive only 15 percent of the quantitatively-based Ph.D.'s. Column 2 of this table assesses their representation among the quantitative degrees, controlling for their representation at each degree level itself. As Table 6 showed, women receive only 30 percent of all Ph.D. degrees. Given that a woman receives a Ph.D. in any field, she is only *half* as likely to obtain that degree in a quantitative field as a man who receives a Ph.D. Women's underrepresentation

among quantitative Ph.D. degrees thus reflects the joint effects of their underrepresentation at the Ph.D. level itself and among quantitative fields at the Ph.D. level. The third column of Table 7 tells us that in 1979/80, a male randomly selected from the age-relevant population was:

- twice as likely as a randomly selected female to have received a quantitatively-based B.A. or biologically-/physically-based professional degree; and
- three times as likely as a randomly selected female to have received a quantitatively-based M.A. or Ph.D.

PROJECTED REPRESENTATION

In sum, certain minorities and women are currently underrepresented among the quantitatively-based disciplines at all degree levels, especially at the Ph.D. level. However, the policy importance of their underrepresentation depends on the projected representational *trends* for these groups. They may evidence rates of change in the 1970s that, projected forward, would achieve their proportionate representation in the 1980s. In this case the decision to invest resources in reducing representational problems depends on whether the projection is plausible and the projected time to secure proportionate representation is acceptable.

Projections are a risky business, especially in policy areas such as this that lack credible dynamic models of choice. However, an examination of trend data on enrollments and degrees conferred tells us whether recent history gives us *any* reason to expect representational problems to resolve themselves.

In interpreting the trend data, it is important to keep certain facts in mind. First, we have postsecondary enrollment data by race, ethnicity, sex, and field from 1968. For degrees conferred by field we have a long time series for women, but only a short one for minorities: from 1973/74 for B.A. degrees and from 1975/76 for M.A., Ph.D., and professional degrees. To compensate for this problem, we piece together data on high school graduation, college freshmen enrollments, and post-

secondary degrees to get some idea of whether the educational attainment probabilities of different subgroups shifted in any dramatic way across the 1970s.

Second, both the Hispanic and Asian-American subgroups experienced substantial in-migration during the 1970s. Trends for these two groups, especially for Hispanics, have to be interpreted differently than those for groups with little in-migration (whites, blacks, and American Indians). Substantial in-migration complicates trend interpretations in two ways. The most obvious is that the age-relevant base population changes in size across time. Periodic Census Bureau surveys of the Hispanic population during the last decade let us estimate population changes for this subgroup. However, no such surveys exist for Asian-Americans, and we cannot make population corrections for this group.

Substantial in-migration can also mean major compositional changes in the educational propensities of the subgroup. If a subgroup is adding large numbers from social classes or countries with low levels of educational attainment, we have to ask what represents attainment success for that subgroup in this country. For the newly immigrant members of a subgroup, high school graduation itself may represent a major achievement. However, if the total subgroup has a sizable component of such individuals, we will underestimate the postsecondary achievement for established residents of the subgroup. It would be preferable to assess postsecondary trends for established residents only, but we do not have the data to make this distinction.

Trends for Racial and Ethnic Groups

With these caveats in mind, we can now examine enrollment and degree data for the racial and ethnic groups.

Enrollment trends. Table 8 tells us the percents of different racial and ethnic groups in the postsecondary "pipeline" for different years. If a particular group shows a substantial increase in enrollments at the B.A. or graduate level in the late 1970s, we might expect that group's share of the degrees conferred to increase in the first half of the 1980s. If a group's underrepresentation among the quanti-

tatively-based degrees is attributable partly to its underrepresentation at the degree level itself, we might also expect that group's share of the quantitatively-based degrees to increase.

Table 8

TRENDS IN FULLTIME POSTSECONDARY ENROLLMENTS BY RACIAL AND ETHNIC GROUP, DEGREE LEVEL, AND YEAR[b]

(1968-1979)

Degree Level	Year	Racial and Ethnic Group (Percent)					
		Total	Whites	Blacks	Hispanics	American Indians	Asian American
Under Graduate Enrollments	1968[c]	100.0	90.0	7.1	1.7	0.5	0.7
	1970[c]	100.0	89.4	6.9	2.1	0.5	1.0
	1972[c]	100.0	87.6	8.3	2.3	0.5	1.0
	1974[c]	100.0	86.5	9.0	2.8	0.6	1.1
	1976	100.0	82.7	10.4	4.5	0.7	1.8
	1978	100.0	81.9	10.4	5.1	0.6	2.0
	1979	100.0	81.3	10.3	5.2	0.6	2.3
Graduate Enrollments[d]	1972[c]	100.0	90.8	5.2	1.4	0.4	2.0
	1974[c]	100.0	90.8	5.5	1.5	0.4	1.8
	1976	100.0	89.2	5.8	2.5	0.4	2.2
	1978	100.0	88.8	5.6	2.6	0.4	2.5
	1979	100.0	87.7	5.8	3.0	0.5	2.9
Professional Degree Enrollments[d]	1972[c]	100.0	92.2	4.7	1.4	0.2	1.3
	1974[c]	100.0	91.9	4.9	1.6	0.3	1.3
	1976	100.0	90.6	4.6	2.5	0.6	1.8
	1978	100.0	90.4	4.5	2.7	0.4	2.0

[a]The percent distributions for fulltime and parttime enrollments and for fulltime enrollments only by racial and ethnic group are either the same or differ by no more than one- or two-tenths of a percentage point. Since we have a longer time series for fulltime than for total enrollments, we have used the fulltime statistics.

[b]Sources: Department of Health, Education, and Welfare, Office for Civil Rights, [illegible] series for Fall 1968, 1970, 1972, and 1974, U.S. Government Printing Office, Washington, D.C.; National Center for Educational Statistics, [illegible] series for Fall 1976, 1978, and 1979, U.S. Government Printing Office, Washington, D.C.

[c]The numbers for these years include non-resident aliens.

[d]The data sources for 1968 and 1970 did not report enrollments separately for graduate and professional schools.

From 1968 to 1979, American Indian undergraduate enrollment remained steady, and the white share decreased. The black, Hispanic, and Asian American shares increased, but these groups also had increased shares of the college age population, as the result of in-migration and/or higher birth rates.[2]

Increases in the Hispanic enrollment share are commensurate with increases in their share of the college-age population. However, for reasons discussed earlier, these numbers may mask an *increase* in enrollment shares for the residentially established Hispanic population.

Increases in the black and Asian-American enrollment shares seem larger than increases in their population shares, indicating that their shares of the B.A. degrees awarded may increase in the early 1980s. As Tables 1-5 showed, black underrepresentation at the B.A. degree level itself accounts partly for their underrepresentation among quantitatively-based B.A. degrees. Thus, blacks may also show some increase in their share of quantitatively-based B.A. degrees, relative to their share of their college-age population.

Again, as Tables 1-5 indicated, Asian-American overrepresentation among quantitatively-based degrees is attributable to their overrepresentation both at the degree levels themselves and among the quantitatively-based degrees at each level. Thus, increases in their share of undergraduate enrollments may show up in the early 1980s as an increase in their share of total B.A. degrees and an even larger increase in their share of quantitatively-based B.A. degrees.

Whites show declines in enrollment shares greater than declines in their shares of the college-age population. These declines may show up in the 1980s as decreases in B.A. and quantitatively-based B.A. shares, relative to their shares of the college-age population. American Indians show little change in either undergraduate enrollment or college-age population shares, suggesting little change in their early 1980s shares of B.A. degrees or quantitatively-based degrees.

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[2] Tables 17-21, below, show the changes in shares of the college-age population across the 1970s for each subgroup.

Relative to changes in their age-relevant populations, all groups show relative stability in their graduate enrollments from 1972 to 1979. Black graduate enrollment shares may not be keeping pace with increases in their shares of the age-relevant population.

Degree trends. We can now look at trends in degrees conferred for the racial and ethnic groups--Tables 9 to 1[illegible]. These tables contain a great deal of information, but we confine our discussion to trends in shares of total degrees and quantitatively-based degrees.

Table 9 shows trends in *associate degrees* from 1975/76 to 1978/79. Blacks, Hispanics, and Asian-Americans show steady increases in their associate degrees; American Indians may show an increase; and whites show a steady decrease in their share. However, for all minority groups increases in their associate degree shares are *less* than increases in their age-relevant populations; for whites, decreases in their associate degree shares, less than decreases in their age-relevant populations. Thus, relative to their age-relevant populations, associate degrees are going *increasingly* to whites and *decreasingly* to minorities.

Table 10 shows trends in total *B.A. degrees* and quantitatively-based B.A. degrees for 1973/74 to 1978/79. The data source for 1973/74 is different from that for subsequent years, and shifts from 1973/74 to 1975/76 should be interpreted cautiously. For this time period the white share of B.A. degrees declines more than their share of the age-relevant population. Although their share of quantitatively-based B.A. degrees declines, the decline is less than that in total B.A. degrees and roughly commensurate with their reduced share of the age-relevant population.

Although blacks show some increase from 1973/74 to 1975/76 in their B.A. degree and quantitative B.A. degree shares, they show no changes since 1975/76.[1] Thus, nothing in the degree (as opposed to enrollment) data suggests a 1980s increase in the black shares of B.A. and quantitative B.A. degrees, either relative to other groups or relative to their share of the age-relevant population.

[1] As we noted earlier, this shift from 1973/74 to 1975/76 may be simply an artifact of different data bases.

Table 9

REPRESENTATION OF RACIAL AND ETHNIC GROUPS AMONG ASSOCIATE DEGREES BY DEGREE FIELD AND YEAR (1975/76 TO 1978/79)[a]

			Field							
Year	Racial and Ethnic Group	Total Associate Degrees	Business and Commerce[b]	Data Processing Technologies[c]	Health and Paramedical Technologies[d]	Mechanical and Engineering Technologies[e]	Natural Science Technologies[f]	Public Service Technologies[g]	Arts & Science and General Program
1975/76	Total (N=454,990)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Whites	85.2	84.3	83.1	86.4	86.2	93.6	83.2	84.4
	Blacks	8.5	9.7	10.4	8.4	7.9	3.7	9.7	8.1
	Hispanics	4.5	4.4	4.7	3.9	4.2	1.6	5.5	5.5
	American Indians	0.5	0.5	0.4	0.5	0.6	0.5	0.5	0.6
	Asian-Americans	1.2	1.2	1.4	0.9	1.1	0.6	1.1	1.4
1976/77	Total (N=504,314)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Whites	84.4	83.2	81.2	86.7	84.8	92.6	82.3	83.4
	Blacks	8.5	10.0	11.5	7.9	8.1	3.7	9.7	8.3
	Hispanics	4.8	4.4	4.8	3.7	4.7	2.1	5.8	5.7
	American Indians	0.7	0.6	0.6	0.6	0.7	0.6	0.7	0.7
	Asian-Americans	1.7	1.8	1.9	1.1	1.7	1.2	1.5	1.9
1978/79	Total (N=505,915)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Whites	82.3	81.2	78.2	87.1	84.0	90.5	79.9	82.2
	Blacks	9.1	10.6	11.4	7.5	8.0	4.8	12.5	9.1
	Hispanics	5.1	5.8	6.4	3.6	4.7	2.4	5.4	6.0
	American Indians	0.6	0.5	0.5	0.6	0.7	0.6	0.7	0.7
	Asian-Americans	1.9	1.7	3.1	1.2	2.6	1.7	1.6	2.0

[a]Data for 1975/76 come from the Department of Health, Education, and Welfare, Office for Civil Rights, [illegible], 1978. Data for 1976/77 come from the Department of Education, National Center for Educational Statistics, [illegible], 1980, Table 111. Data for 1978/79 come from the Department of Education, Office for Civil Rights, [illegible], 1981.

[b]Business and commerce includes, for example, accounting, banking and finance, secretarial, marketing, hotel and restaurant management, photography.

[c]Data processing includes, for example, keypunch operator, programmer, computer operator.

[d]Health and paramedical technologies includes, for example, dental hygiene, nursing (R.N.), occupational therapy, medical laboratory assistant, psychiatric assistance.

[e]Mechanical and engineering technologies includes, for example, architectural drafting, welding, chemical, textile, nuclear technologies.

[f]Natural science technologies includes, for example, agriculture, forestry and wildlife, home economics, marine and oceanographic studies.

[g]Public service technologies includes, for example, police and law enforcement, fire control, public administration and management.

Table 10

REPRESENTATION OF RACIAL AND ETHNIC GROUPS AMONG B.A. DEGREES BY DEGREE FIELD AND YEAR (1973/74 TO 1978/79)[a]

Year	Racial and Ethnic Group	Total B.A. Degrees	Fields (Percent)										
			Quantitatively-Based Disciplines										
			Total	Physical Sciences	Mathematics	Computer Sciences	Biological Sciences	Engineering	Social Sciences	Business	Education	All Other
1973/74	Total (N=989,200)	100.0	100.0	100.0	100.0	b	100.0	100.0	100.0	100.0	100.0	100.0
	Whites	92.2	92.9	94.8	91.9	b	89.7	94.9	90.9	92.4	90.4	93.2
	Blacks	5.3	2.9	2.7	4.6	b	3.6	1.8	6.6	4.9	7.9	4.2
	Hispanics	1.3	1.2	1.2	0.7	b	1.1	1.4	1.4	1.2	1.1	1.4
	American Indians	0.3	0.2	0.2	0.1	b	0.2	0.4	0.3	0.3	0.3	0.3
	Asian-Americans	0.9	1.6	1.1	1.7	b	1.7	1.5	0.9	1.2	0.4	0.9
1975/76	Total (N=912,000)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Whites	89.0	91.1	91.3	90.4	89.7	90.4	91.3	87.0	88.8	87.0	90.4
	Blacks	6.5	5.0	3.1	4.1	6.0	4.3	3.2	8.1	6.7	9.1	5.2
	Hispanics	2.9	2.6	1.8	2.2	1.9	2.8	2.9	3.3	2.8	2.9	2.8
	American Indians	0.4	0.3	0.3	0.4	0.1	0.3	0.4	0.3	0.4	0.5	0.4
	Asian-Americans	1.2	2.1	1.5	2.0	2.1	2.3	2.1	1.2	1.1	0.5	1.2
1976/77	Total (N=899,428)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Whites	89.5	91.5	93.4	91.0	90.0	90.7	92.0	87.1	89.5	87.7	90.8
	Blacks	6.5	4.0	3.1	5.1	5.9	4.6	3.0	8.4	6.7	9.1	5.4
	Hispanics	2.1	1.8	1.5	1.6	1.5	1.9	2.0	2.6	1.7	2.1	2.0
	American Indians	0.4	0.3	0.3	0.2	0.3	0.3	0.3	0.4	0.3	0.5	0.4
	Asian-Americans	1.5	2.4	1.7	2.3	2.7	2.5	2.7	1.5	1.8	0.6	1.5
1978/79	Total (N=911,637)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Whites	88.1	89.8	92.5	88.7	88.2	87.8	90.8	86.0	87.9	86.0	89.1
	Blacks	6.6	4.1	3.1	5.7	6.0	5.1	3.1	8.2	6.7	9.1	6.0
	Hispanics	3.3	2.9	2.2	2.5	2.5	3.3	2.7	3.8	3.3	3.8	3.0
	American Indians	0.4	0.3	0.3	0.4	0.3	0.3	0.3	0.5	0.3	0.5	0; 0.4
	Asian-Americans	1.7	2.9	1.9	2.8	3.1	3.0	3.2	1.6	1.9	0.7	1.5

[a]Sources: Data for 1973/74 come from the American Council on Education, *A Fact Book on Higher Education*, #4, 1976, Table 76.225. Data for 1975/76 come from the Department of Health, Education, and Welfare, Office for Civil Rights, *Data on Earned Degrees Conferred from Institutions of Higher Education by Race, Ethnicity, and Sex, Academic Year 1975-76*, 1978. Data for 1976/77 come from the Department of Education, National Center for Educational Statistics, *Digest of Educational Statistics*, 1980, Table 111. Data for 1978/79 come from the Department of Education, Office for Civil Rights, *Data on Earned Degrees Conferred by Institutions of Higher Education by Race, Ethnicity, and Sex, Academic Year 1978-1979*, 1981.

[b]Computer science B.A.s are included in mathematics.

In general, Hispanics show an increase in their share of B.A. and quantitative B.A. shares. In any given year their share of the quantitative B.A. degrees is less than that of total B.A. degrees, and the gap between the two does not close across time. Increases in their B.A. shares are roughly commensurate with increases in their share of the age-relevant population.

American Indians show steady shar of B.A. and quantitative B.A. degrees across time. Asian-Americans show increases in both shares greater than increases in their share of the age-relevant population. In every year Asian-Americans have larger shares of quantitative B.A. degrees than of total B.A. degrees. The difference between the two does not change across time.

Table 11 shows the trends in *M.A. degrees* for 1975/76 to 1978/79. During this short period we see little, if any change, in black, Hispanic, or American Indian shares of M.A. and quantitative M.A. degrees. This lack of change was commensurate with the lack of any significant change in these groups' shares of the age-relevant population. We see a decrease in white and increase in Asian-American shares of M.A. and quantitative M.A. degrees. Again, however, these changes are approximately commensurate with changes in their shares of the age-relevant population.

Table 12 shows the *Ph.D.* trends from 1975/76 to 1979/80. Any marked shift from 1978/79 to 1979/80 should be interpreted cautiously because the data source for the last year is different from that for the first three years. Whites show a decrease in their shares of Ph.D. and quantitative Ph.D. degrees slightly greater than the decrease in their age-relevant population share. Blacks and Hispanics show little shift across time in their Ph.D. or quantitative Ph.D. shares; their age-relevant population shares also show little shift.

The American Indian share of Ph.D. degrees seems to have edged up, with no change in share of the age-relevant population. However, their share of quantitative Ph.D. degrees did not change. Across the four years Asian-Americans doubled their shares of both Ph.D. and quanti-

Table 11

REPRESENTATION OF RACIAL AND ETHNIC GROUPS AMONG M.A. DEGREES BY DEGREE FIELD AND YEAR (1975/76 TO 1978/79)[a]

Year	Racial and Ethnic Group	Total M.A. Degrees	Fields (Percent): Quantitatively-Based Disciplines: Total	Physical Sciences	Mathematics	Computer Sciences	Biological Sciences	Engineering	Social Sciences	Business	Education	All Other
1975/76	Total (N=294,390)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Whites	89.3	92.3	92.4	91.8	93.2	92.7	91.9	90.2	92.5	86.9	90.2
	Blacks	6.9	2.7	2.9	3.7	2.7	3.5	1.9	5.9	4.0	9.8	5.6
	Hispanics	2.2	1.6	1.6	1.6	0.8	1.5	1.9	2.3	1.5	2.2	2.6
	American Indians	0.3	0.3	0.2	0.2	0.3	0.3	0.3	0.2	0.2	0.3	0.3
	Asian-Americans	1.4	3.2	3.0	2.7	3.0	2.1	4.0	1.3	1.9	0.8	1.5
1976/77	Total (N=298,322)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Whites	88.9	91.4	93.3	91.7	90.6	93.1	90.0	88.5	92.4	86.4	85.3
	Blacks	7.1	2.5	2.0	4.0	2.8	3.1	1.9	6.7	3.8	10.2	5.3
	Hispanics	2.0	1.6	1.2	1.3	2.0	1.1	2.0	2.9	1.4	2.2	2.0
	American Indians	0.3	0.3	0.5	0.4	0.1	0.2	0.2	0.3	0.3	0.4	2.8
	Asian-Americans	1.7	4.2	3.1	2.7	4.5	2.4	6.0	1.7	2.2	0.8	1.9
1978/79	Total (N=281,465)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Whites	88.5	90.2	92.8	91.5	89.9	91.4	88.3	89.2	90.7	86.2	89.6
	Blacks	6.9	2.5	1.8	2.8	2.6	3.4	2.1	6.4	4.7	9.9	5.7
	Hispanics	2.3	1.6	1.4	1.4	1.0	1.8	1.9	2.4	1.6	2.6	2.5
	American Indians	0.4	0.3	0.6	0.3	0.6	0.3	0.2	0.3	0.3	0.4	0.3
	Asian-Americans	2.0	5.3	3.4	4.1	5.9	3.2	7.5	1.7	2.7	8.8	1.9

[a]Sources: Data for 1975/76 come from the Department of Health, Education, and Welfare, Office for Civil Rights, *Data on Earned Degrees Conferred from Institutions of Higher Education by Race, Ethnicity, and Sex, Academic Year 1975-76*, 1978. Data for 1976/77 come from the Department of Education, National Center for Educational Statistics, *Digest of Educational Statistics*, Table 111. Data for 1978/79 come from the Department of Education, Office for Civil Rights, *Data on Earned Degrees Conferred by Institutions of Higher Education by Race, Ethnicity, and Sex, Academic Year 1978-1979*, 1981.

Table 12

REPRESENTATION OF RACIAL AND ETHNIC GROUPS AMONG PH.D. DEGREES BY DEGREE FIELD AND YEAR (1975/76 TO 1979/80)[a]

Year	Racial and Ethnic Group	Total Ph.D. Degrees	Fields (Percent): Quantitatively-Based Disciplines: Total	Physical Sciences	Mathematics	Computer Sciences	Biological Sciences	Engineering	Social Sciences	Business	Education	All Other
1975/76	Total (N=29,731)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Whites	92.3	91.6	94.1	93.6	97.0	94.4	91.3	94.3	93.8	87.8	93.5
	Blacks	4.1	1.4	1.4	1.3	0.0	1.7	1.1	3.0	2.1	9.0	3.2
	Hispanics	1.4	1.0	1.1	1.7	0.5	0.9	0.9	1.4	1.1	1.9	1.3
	American Indians	0.3	0.2	0.3	0.1	0.5	0.1	0.2	0.2	0.9	0.5	0.3
	Asian-Americans	2.0	3.8	3.1	3.2	2.0	2.9	6.6	1.2	2.3	0.8	1.6
1976/77	Total (N=29,364)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Whites	91.4	92.6	93.4	91.9	93.6	93.5	89.9	92.5	94.5	87.4	93.2
	Blacks	4.3	1.6	1.6	1.5	0.6	1.7	1.3	3.7	1.8	9.0	3.0
	Hispanics	1.8	1.3	1.4	2.7	0.0	1.0	1.5	2.0	1.0	2.2	1.9
	American Indians	0.3	0.3	0.2	0.5	0.6	0.5	0.1	0.3	0.4	0.4	0.3
	Asian-Americans	2.2	4.2	3.4	3.5	5.3	3.4	7.2	1.6	2.3	1.0	1.7
1978/79	Total (N=28,774)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Whites	90.8	91.4	92.3	91.6	93.1	93.3	85.8	91.7	94.6	87.5	92.6
	Blacks	4.4	1.7	1.8	2.3	2.1	1.5	1.5	4.4	2.6	8.6	3.5
	Hispanics	1.6	1.0	1.0	1.0	0.5	1.1	1.4	1.9	0.7	1.9	1.7
	American Indians	0.4	0.2	0.3	0.0	0.0	0.2	0.1	0.5	0.4	0.6	0.2
	Asian-Americans	2.8	5.7	4.6	5.1	4.3	4.0	11.2	1.6	1.7	1.3	2.1
1979/80	Total (N=27,350)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Whites	89.8	89.4	91.0	90.1	94.3	92.6	79.9	91.4	b	87.3	90.5
	Blacks	4.0	1.1	0.6	2.0	0.0	1.3	1.1	3.9	b	8.5	3.2
	Hispanics	1.8	1.1	1.1	0.8	0.6	0.9	1.7	1.9	b	2.2	2.4
	American Indians	0.4	0.2	0.3	0.0	0.0	0.3	0.2	0.3	b	0.8	1.7
	Asian-Americans	4.0	8.1	7.0	7.1	5.1	4.8	17.1	2.6	b	1.3	2.3

[a]Data for 1975/76 come from the Department of Health, Education, and Welfare, Office for Civil Rights, *Data on Earned Degrees Conferred from Institutions of Higher Education by Race, Ethnicity, and Sex, Academic Year 1975-76*. Data for 1976/77 comes from the Department of Education, National Center for Educational Statistics, *Digest of Educational Statistics*, 1980, Table 111. Data for 1978/79 come from the Department of Education, Office for Civil Rights, *Data on Earned Degrees Conferred by Institutions of Higher Education by Race, Ethnicity, and Sex, Academic Year 1978-1979*, 1981. Data for 1979/80 come from the National Academy of Sciences and National Science Foundation, *Summary Report 1980, Doctorate Recipients from United States Universities*, 1980.

[b]The data source for 1979/80 includes business in all other fields.

tative Ph.D. degrees, share increases greater than increases in their population shares.

Finally, Table 13 shows trends for *professional degrees* from 1975/76 to 1978/79. Trends in these degrees affect our interpretation of minority trends in quantitative Ph.D. degrees. A substantial percent of professional degrees (e.g., medicine) reflect scientific interests and training as much as some of the quantitative Ph.D. fields. We would interpret the smaller shares and flat trends in black, Hispanic, and American Indian quantitative Ph.D. shares differently if we saw that they had: (1) larger shares of scientifically-based professional degrees than of quantitative Ph.D. degrees, or (2) sizable increases in their shares of these professional degrees.

We find the second for none of the three groups. However, we certainly find the first for blacks and Hispanics. Relative to the other groups, blacks and Hispanics chose a scientifically-based professional degree more frequently than a quantitative Ph.D. degree. In other words, the scientific professional degrees "drain off" more of the scientific talent in the black and Hispanic groups than in the other groups.

Conclusion. In sum, the undergraduate enrollment data suggest that in the early 1980s blacks and Asian-Americans may show an increase in their B.A. shares beyond increases in their shares of the age-relevant population. The graduate enrollment data give us no reason to expect much change in the early 1980s in any subgroup's share of the graduate degrees.

The degree data suggest that, relative to age-relevant population shares, increasing percents of associate degrees will go to whites; decreasing percents, to minority groups. Whites show a slight decline in their shares of B.A., M.A., and Ph.D. degrees, but no real change in their shares of quantitative B.A., M.A., and Ph.D. degrees. Asian-Americans show increases in their shares of total and quantitative B.A., M.A., and Ph.D. degrees. Blacks, Hispanics, and American Indians show little change across time once changes in their age-relevant population shares are considered.

Table 13

REPRESENTATION OF RACIAL AND ETHNIC GROUPS AMONG PROFESSIONAL DEGREES BY DEGREE FIELD AND YEAR (1975/76 TO 1978/79)[a]

Year	Racial and Ethnic Group	Total Professional Degrees	Fields (Percent)			
			Medicine	Law	Other Physically- or Biologically-Based Fields[b]	Other non-Physically- or Biologically-Based Fields[c]
1975/76	Total (N=60,161)	100.0	100.0	100.0	100.0	100.0
	Whites	91.4	[illegible]	[illegible]	92.1	[illegible]
	Blacks	4.4	5.3	4.7	2.5	[illegible]
	Hispanics	2.3	2.3	2.7	1.8	[illegible]
	American Indians	0.3	0.4	0.2	0.4	0.8
	Asian-Americans	1.5	1.7	1.0	3.4	0.4
1976/77	Total (N=63,252)	100.0	100.0	100.0	100.0	[illegible]
	Whites	92.4	90.7	92.5	93.0	[illegible]
	Blacks	4.0	5.5	4.0	2.6	[illegible]
	Hispanics	1.7	1.7	2.0	1.1	1.2
	American Indians	0.3	0.2	[illegible]	0.4	[illegible]
	Asian-Americans	1.6	2.0	1.2	3.0	0.4
1978/79	Total (N=66,679)	100.0	100.0	100.0	100.0	100.0
	Whites	91.2	89.0	91.7	91.5	93.2
	Blacks	4.2	5.1	4.3	2.7	[illegible]
	Hispanics	2.5	3.1	2.6	1.8	[illegible]
	American Indians	0.3	0.3	0.3	0.5	[illegible]
	Asian-Americans	1.8	2.5	1.1	3.7	0.7

[a]Sources: Data for 1975/76 come from the Department of Health, Education, and Welfare, Office for Civil Rights, *Data on Earned Degrees Conferred from Institutions of Higher Education by [illegible], Ethnicity, and Sex, Academic Year 1975-76*, 1978. Data for 1976/77 come from the Department of Education, National Center for Educational Statistics, *Digest of Education Statistics*, 1980, Table 111. Data for 1978/79 come from the Department of Education, Office for Civil Rights, *Data on Earned Degrees Conferred by Institutions of Higher Education by [illegible], Ethnicity, and Sex, Academic Year 1978-1979*, 1981.

[b]Other physically- or biologically-based professional degrees include degrees in: dentistry, optometry, osteopathy, podiatry, veterinary medicine, and pharmacy.

[c]Other non-physically- or biologically-based professional degrees include degrees in theology only.

Trends for Women

The trends for women are strong and positive. As Tables 14-16 show, in the last decade women earned an increasing percent of the degrees conferred at *every* level--associate, B.A., M.A., Ph.D., and

Table 14

PERCENT FEMALE FOR ASSOCIATE DEGREE OCCUPATIONAL FIELDS BY YEAR (1970/71 TO 1978/79)[a]

	Total Degrees		Fields (Percent Female)					
Year	N[b]	Percent Female	Business and Commerce	Data Processing Technologies	Health and Para-Medical Technologies	Mechanical and Engineering Technologies	Natural Science Technologies	Public Service Technologies
1970/71	153,549	46	54	36	92	1.4	23	39
1971/72	190,039	47	54	34	90	1.4	27	40
1974/75	277,161	50	57	36	88	2.5	30	39
1975/76	313,014	49	55	41	86	3.4	33	37
1976/77	334,509	50	56	43	87	3.9	34	40
1977/78	352,038	52	58	43	88	5.1	38	44
1978/79	352,708	54	62	47	88	6.0	38	47

[a]Source: U.S. Department of Health, Education, and Welfare and Department of Education, National Center for Educational Statistics, *Digest of Statistics* series, 1972-1981.

[b]Total numbers do not correspond to those in Table 9 because the *Digest* data series includes associate occupational degrees only. It excludes the arts and science and general program degrees, which represent about a third of the total associate degrees.

Table 15

PERCENT FEMALE BY DEGREE LEVEL AND YEAR (1969/70 TO 1979/80)[a]

Degree Level	Year	Total Degrees: N	Total Degrees: Percent Female	Fields (Percent Female) — Quantitatively-Based Disciplines: Total	Physical Sciences	Mathematics	Computer Sciences	Biological Sciences	Engineering	Economics	Social Sciences	Business	Education	All Other
B.A.	1969/70	792,316	43	17	14	37	13	28	1	11	43	9	75	52
	1970/71	839,730	43	17	14	38	14	29	1	12	43	9	74	53
	1971/72	887,273	44	17	15	39	14	29	1	12	42	10	74	52
	1972/73	922,362	44	18	15	40	15	30	1	14	32	11	74	53
	1973/74	945,776	44	19	17	41	16	31	2	15	44	13	73	53
	1974/75	922,933	45	21	18	42	19	33	2	17	46	16	73	55
	1975/76	925,746	45	22	19	41	20	35	3	20	47	20	73	54
	1976/77	919,549	46	23	20	42	24	36	5	23	49	23	72	55
	1977/78	921,204	47	24	21	41	25	38	7	25	50	27	72	57
	1978/79	921,390	48	24	23	42	28	40	8	27	52	31	73	59
	1979/80	940,251	49	25	24	42	30	42	9	30	55	34	73	60
M.A.	1969/70	208,291	40	13	14	30	9	31	1	12	39	4	55	50
	1970/71	230,509	40	13	13	29	10	34	1	13	32	4	56	50
	1971/72	251,633	41	13	14	30	11	33	2	13	33	4	57	50
	1972/73	263,371	41	13	13	30	11	30	2	13	33	5	58	49
	1973/74	277,033	43	14	14	31	13	30	2	14	34	7	60	50
	1974/75	292,450	45	14	14	33	15	30	2	15	36	8	62	51
	1975/76	311,771	46	15	15	34	14	32	4	16	40	12	64	52
	1976/77	317,164	47	16	17	35	17	34	4	18	41	14	66	52
	1977/78	311,620	48	17	17	34	19	35	5	20	43	17	68	54
	1978/79	301,079	49	18	18	35	19	38	6	20	46	19	69	55
	1979/80	299,095	49	18	19	36	21	37	7	21	48	22	70	55
Ph.D	1969/70	29,866	13	7	5	8	2	14	1	7	19	2	20	19
	1970/71	32,107	14	7	6	8	2	16	1	7	20	3	21	19
	1971/72	33,363	16	8	7	8	7	17	1	8	21	2	24	21
	1972/73	34,777	18	9	7	10	8	20	2	6	24	6	25	23
	1973/74	33,816	19	10	7	10	5	20	2	10	25	5	27	24
	1974/75	34,083	21	11	8	11	7	22	2	9	28	4	31	26
	1975/76	34,064	23	11	9	11	9	21	2	11	28	5	33	28
	1976/77	33,232	24	12	10	13	9	21	3	11	32	6	35	29
	1977/78	32,131	26	13	10	15	8	24	2	11	34	8	39	29
	1978/79	32,730	28	15	11	17	13	26	3	13	36	12	42	30
	1979/80	32,632	30	15	12	14	11	26	4	15	38	14	44	31

[a]Source: National Center for Educational Statistics. *Digest of Educational Statistics* series, 1971-1981, Department of Health, Education, and Welfare, and Department of Education. The data reported in the *Digest* come from the National Center's *Earned Degrees Conferred* data series for 1969-70 to 1979-80.

professional. Today women are still underrepresented at the Ph.D. and professional degree levels. However, they showed large increases in both of these degree categories in the 1970s. If these rates continue, by 1990 the female percents of Ph.D. degrees and professional degrees should approximately equal their percent of the age-relevant population.

Table 16

PERCENT FEMALE OF PROFESSIONAL DEGREES
BY YEAR (1969/70 TO 1979/80)[a]

	Total Degrees		Fields (Percent Female)			
Year	N	Percent Female	Medicine	Law	Other Physically- or Biologically Based Fields[b]	Other non-Physically- or Biologically-Based Fields[c]
1969/70[d]	34,918	5	8	5	3	2
1970/71	48,137	8	9	7	10	7
1971/72	54,617	8	9	7	11	7
1972/73	63,170	9	9	8	12	9
1973/74	67,403	12	11	11	14	11
1974/75	69,904	15	13	15	16	13
1975/76	75,855	18	16	19	18	15
1976/77	79,296	20	19	22	20	17
1977/78	80,935	23	21	26	23	19
1978/79	83,020	25	23	29	25	21
1979/80	83,666	27	23	30	27	22

[a]Source: National Center for Education Statistics. *Earned Degrees Conferred* series, 1969-70 to 1979-80. Department of Health, Education, and Welfare and Department of Education.

[b]Other physically- or biologically-based professional degrees include degrees in: dentistry, optometry, osteopathy, podiatry, veterinary medicine, and pharmacy.

[c]Other non-physically- or biologically-based professional degrees include degrees in theology and architecture.

[d]Data for 1969/70 do not include pharmacy and architecture degrees. In 1970/71 these two fields accounted for 10,171 degrees, or 21 percent of the total professional degrees. Both of these fields have relatively high female proportions.

During the 1970s women also earned increasing percents of the quantitative degrees at each degree level--B.A., M.A., Ph.D., and professional. However, their rates of increase for the quantitative degrees were much lower than for the total degrees. As we show later, the increases that we do observe are entirely attributable to increases in the percent of total degrees that go to women, *not* to changes in their field preferences. Thus, unless women begin to change their field preferences, further increases in their percents of quantitative degrees depend on increased percents of women at each degree level. It is not clear that we can expect major percent increases at the lower degree levels.

LOSSES FROM THE EDUCATIONAL PIPELINE

At any given degree level, a group's share of the quantitative degrees reflects two factors: persistence in the pipeline and field choice. This and the next section assess the separate contributions of these two factors to each group's share of quantitative Ph.D. degrees.

To estimate persistence, we need a data base that spans the years required for the average student to move from high school (median age 18 years) to the Ph.D. degree (median age 32 years). The base can be of three kinds: (1) a long cross-sectional time series that lends itself to cohort analysis; (2) longitudinal (panel) studies with long time frames; or (3) retrospective studies that measure educational histories.

The second and third kind of data bases exist, but do not adequately sample either the minority groups or those who obtain graduate degrees. As we have already pointed out, the cross-sectional time series is good for men and women and very limited for minorities. For minorities the available cross-sectional time series do not let us estimate persistence from high school graduation to the Ph.D. for even one complete cohort. The first year for which we have B.A. degree data is 1973/74. If we assume that B.A. graduates were 22 years old in that year, we need Ph.D. data at least eight years later (1981/82) and preferably 10 years later (1983/84) to observe persistence.

However, we can observe retention of one group relative to another

for parts of the pipeline, especially for women relative to men. For example, if we assume four years from college entry to the B.A. degree and three years from the B.A. degree to the M.A. degree, we have the data points to follow the college freshman class of 1972 through the B.A. (1976) and the M.A. (1979). The discussion in this section assumes the following elapsed time between pairs of events:

High school graduation → College entry	=	0 years
College entry → B.A. degree	=	4 years
B.A. degree → M.A. degree	=	3 years
B.A. degree → Professional Degree	=	5 years
B.A. degree → Ph.D. degree	=	10 years

All subgroups lose members as the total cohort progresses through the pipeline. Here the question is whether a subgroup losses a smaller or larger percent at each point than all other subgroups. Tables 17-22 show the following about each subgroup's losses from the pipeline.

- Relative to all other groups, non-Hispanic whites have *greater* persistence at each point in the pipeline except from the B.A. to the M.A. degree (Table 17). The cumulative effect of their lower losses can be seen by comparing their percent of all 18 year olds with their percents of B.A. degrees four years later, M.A degrees 7 years later, or professional degrees 9 years later. For example, they represented 81.5 percent of all 18 year olds in 1972 and 89.5 percent of the 1976 college graduates.
- Relative to non-blacks, blacks have *less* persistence at each stage of the educational pipeline except from the B.A. to the M.A. degree (Table 18). The cumulative effects of their *higher* loss rates can be seen by noting that in 1972 they represented 12.7 percent of all 18 year olds, 10.5 percent of all 1972 high school graduates, 8.7 percent of all 1972 college freshmen, and 6.5 percent of all B.A. graduates. They represented 12.3 percent of all 18 year olds in 1970 and 4.2 percent of all professional degree graduates in 1979.

Table 17

PERCENT NON-HISPANIC WHITE AT POINTS IN THE EDUCATIONAL PIPELINE[a] RELATIVE TO THE PERCENT NON-HISPANIC WHITE OF AGE-RELEVANT POPULATION[b] BY YEAR (1970 TO 1980)

	Percent Non-Hispanic White									
Year	All 18 Year Olds	High School Graduates	College Freshmen[d]	All 22 Year Olds	B.A. Degrees	All 25-29 Year Olds	M.A. Degrees	Professional Degrees	All 30-34 Year Olds	Ph.D. Degrees
1970	81.8	89.3[c]	NA							
1971	81.7	90.4[c]	91.4							
1972	81.5	88.3[c]	87.3							
1973	80.8	88.5[c]	88.5							
1974	79.1	88.2[c]	88.6	81.3	92.2					
1975	79.1	88.6[c]	86.5	81.2						
1976	79.0	88.3[c]	86.2	80.4	89.0	81.9	89.3	91.4	81.7	92.3
1977	78.6	83.1	86.9	80.1	89.5	81.3	88.9	92.4	82.4	91.4
1978	78.4	82.7	88.5	79.3		80.3			82.1	
1979	78.0	82.7	86.3	79.7	88.1	80.3	88.5	91.2	81.7	90.8
1980	76.1	82.5	86.0	77.5		78.3			80.0	89.8

[a] Sources: The percent non-Hispanic white for B.A., M.A., Ph.D. and professional degrees comes from Tables 10 to 13. The percent non-Hispanic white for high school graduates comes from the National Center for Educational Statistics, [illegible] series, 1971-1982. The percent non-Hispanic white for college freshmen comes from the Cooperative Institutional Research Program at the University of California Los Angeles, *The American Freshman: [illegible]* series from 1971 to 1980.

[b] Sources: U.S. Bureau of the Census, Current Population Reports, Series P-25, No. 917, *Preliminary Estimates of the [illegible] by Age, Sex, and Race: 1970 to 19[illegible]*, U.S. Government Printing Office, Washington, D.C. 1982; U.S. Bureau of the Census, 1980 Census of the Population Supplementary Report, PC80-SL-1, *Age, Sex, Race, and [illegible] of the Population by Regions, Divisions, and States: 1980*, U.S. Superintendent of Documents, Washington, D.C.

[c] Data on the number of Hispanic high school graduates by year do not exist before 1977. We are unable to determine the percent of non-Hispanic white high school graduates for the years 1971-1976. If the percent Hispanic graduates for 1977-1980 can be generalized to earlier years, the percent of white high school graduates should be reduced between 4 and 5 percentage points to yield the percent of non-Hispanic white graduates for the years 1971-1976.

[d] "College freshmen" refers to first-time and full-time freshmen in college.

Table 18

PERCENT BLACK AT POINTS IN THE EDUCATIONAL PIPELINE[a] RELATIVE TO THE PERCENT BLACK OF AGE-RELEVANT POPULATION[b] BY YEAR (1970 TO 1980)

	Percent Black									
Year	All 18 Year Olds	High School Graduates	College Freshmen[c]	All 22 Year Olds	B.A. Degrees	All 25-29 Year Olds	M.A. Degrees	Professional Degrees	All 30-34 Year Olds	Ph.D. Degrees
1970	12.1	9.7	NA							
1971	12.4	8.7	6.3							
1972	12.7	10.5	8.7							
1973	13.0	10.3	7.8							
1974	13.3	10.5	7.4	11.9	5.3					
1975	13.4	10.1	9.0	12.1						
1976	13.4	10.3	8.4	12.3	6.5	11.0	6.9	4.4	10.7	4.1
1977	13.8	10.5	8.8	12.6	6.5	11.4	7.1	4.0	10.4	4.3
1978	13.9	10.0	8.1	13.9		11.7			10.5	
1979	13.9	10.0	9.2	12.9	6.6	11.9	6.9	4.2	10.7	4.4
1980	14.1	11.5	9.2	12.9		12.1			10.9	4.0

[a] Sources: The percent black for B.A., M.A., Ph.D. and professional degrees comes from Tables 10 to 13. The percent black for high school graduates comes from the National Center for Educational Statistics, *Digest of Educational Statistics* series, 1971-1982. The percent black for college freshmen comes from the Cooperative Institutional Research Program at the University of California Los Angeles, *The American Freshman: National Norms* series from 1971 to 1980.

[b] Sources: U.S. Bureau of the Census, Current Population Reports, Series P-25, No. 917, *Preliminary Estimates of the Population of the United States by Age, Sex, and Race: 1970 to 1981*, U.S. Government Printing Office, Washington, D.C., 1982; U.S. Bureau of the Census, 1980 Census of the Population Supplementary Report, PC80-S1- 1, *Age, Sex, Race, and Spanish Origin of the Population by Regions, Divisions, and States: 1980*, U.S. Superintendent of Documents, Washington, D.C.

[c] "College freshmen" refers to first-time and full-time freshmen in college.

- As Table 19 shows, we have no data on the percent of Hispanic high school graduates from 1970 through 1976. Although the Hispanic percents are somewhat unstable, the numbers suggest that, relative to non-Hispanics, Hispanics have *higher* losses at each stage in the pipeline through college entry. Once they have entered college, they evidence *lower* or *average* losses. For example, they represent 4.4 percent of the 1972 18 year olds, 2.1 percent of the 1972 college freshmen, and 2 percent of the 1979 M.A. degrees.
- The American Indian data displayed in Table 20 indicate that, relative to their percent of all 18 year olds, they enter college at higher rates than all non-Indians. This is unlikely; either the Census population estimates are low or the estimates of Indian college freshmen high.[4] If we accept the college freshmen estimates, American Indians have very high losses between college entry and the B.A. degree. Their losses are two-thirds greater than those of non-Indians. Even if we reduce the college freshmen estimates by a third, they still have higher losses from college entry to graduation than all non-Indians. After the B.A. their losses stabilize, being average or only somewhat higher than those for all non-Indians.
- Table 21 shows that Asian-Americans enter college in approximately equal proportion to their percent of all 18 year olds. After college entry their losses from the educational pipeline are *lower* at each stage than those of non-Asian-Americans. For example, they represent 1.1 percent of the 1972 college freshmen, 1.2 percent of the 1976 college graduates, and 2 percent of the 1979 M.A. graduates.
- As Table 22 reveals, relative to men, women had stable and lower losses at the high school degree level from 1970 to 1980.

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[4] Brown and Stent (1977) noted the same discrepancy that we observed. They concluded that the Bureau of the Census had underestimated the size of the American Indian population. For their reasoning, see pages 21 through 27 of their publication.

Table 19

PERCENT HISPANIC AT POINTS IN THE EDUCATIONAL PIPELINE[a] RELATIVE TO THE PERCENT HISPANIC OF AGE-RELEVANT POPULATION[b] BY YEAR (1970 TO 1980)

	Percent Hispanic									
Year	All 18 Year Olds	High School Graduates	College Freshmen[c]	All 22 Year Olds	B.A. Degrees	All 25-29 Year Olds	M.A. Degrees	Professional Degrees	All 30-34 Year Olds	Ph.D. Degrees
1970	4.3	NA	NA							
1971	4.5	NA	1.3							
1972	4.4	NA	2.1							
1973	4.7	NA	1.7							
1974	6.0	NA	2.1	5.1	1.3					
1975	5.8	NA	2.4	5.0						
1976	5.8	NA	2.2	5.4	2.9	5.0	2.2	2.3	5.5	1.4
1977	5.8	5.0	2.3	5.3	2.1	5.0	2.0	1.7	5.0	1.8
1978	5.8	4.2	1.9	5.8		5.7			5.1	1.6
1979	6.0	4.9	2.2	5.3	3.3	5.5	2.0	2.5	5.2	1.8
1980	7.5	4.2	3.0	7.3		7.0			6.3	

[a]Sources: The percent Hispanic for B.A., M.A., Ph.D. and professional degrees comes from Tables 10 to 13. The percent Hispanic for high school graduates comes from the National Center for Educational Statistics, *Digest of Educational Statistics* series, 1971-1982. The percent Hispanic for college freshmen comes from the Cooperative Institutional Research Program at the University of California Los Angeles, *The American Freshman: National Norms* series from 1971 to 1980.

[b]Sources: U.S. Bureau of the Census, Current Population Reports, Series P-25, No. 917, *Preliminary Estimates of the Population of the United States by Age, Sex, and Race: 1970 to 1981*, U.S. Government Printing Office, Washington, D.C., 1982; U.S. Bureau of the Census, Current Population Reports, Series P-20, Nos. 250, 264, 290, 329, 339, and 354, *Persons of Spanish Origin in the United States* data series for the years 1971, 1972, 1973, 1975, 1977, 1978, and 1979, U.S. Government Printing Office, Washington, D.C.; U.S. Bureau of the Census, 1980 Census of the Population Supplementary Report, PC80-S1-1, *Age, Sex, Race, and Spanish Origin of the Population by Regions, Divisions, and States: 1980*, U.S. Superintendent of Documents, Washington, D.C.

[c]"College freshmen" refers to first-time and full-time freshmen in college.

Table 20

PERCENT AMERICAN INDIAN AT POINTS IN THE EDUCATIONAL PIPELINE[a] RELATIVE TO THE PERCENT AMERICAN INDIAN OF AGE-RELEVANT POPULATION[b] BY YEAR (1970 TO 1980)

	Percent American Indian									
Year	All 18 Year Olds	High School Graduates	College Freshmen[c]	All 22 Year Olds	B.A. Degrees	All 25-29 Year Olds	M.A. Degrees	Professional Degrees	All 30-34 Year Olds	Ph.D. Degrees
1970	0.7	NA	NA							
1971	0.7	NA	0.9							
1972	0.6	NA	1.1							
1973	0.6	NA	0.9							
1974	0.7	NA	0.9	0.7	0.3					
1975	0.7	NA	0.9	0.7						
1976	0.7	NA	0.9	0.7	0.4	0.7	0.3	0.3	0.6	0.3
1977	0.7	NA	0.8	0.7	0.4	0.7	0.3	0.3	0.6	0.3
1978	0.7	NA	1.1	0.7		0.6			0.6	
1979	0.8	NA	1.0	0.7	0.4	0.6	0.4	0.3	0.6	0.4
1980	0.8	NA	0.8	0.7		0.6			0.6	0.4

[a] Sources: The percent American Indian for B.A., M.A., Ph.D. and professional degrees comes from Tables 10 to 13. The percent American Indian for high school graduates comes from the National Center for Educational Statistics, *Digest of Educational Statistics* series, 1971-1982. The percent American Indian for college freshmen comes from the Cooperative Institutional Research Program at the University of California Los Angeles, *The American Freshman: National Norms* series from 1971 to 1980.

[b] Sources: U.S. Bureau of the Census, Current Population Reports, Series P-25, No. 917, *Preliminary Estimates of the Population of the United States by Age, Sex, and Race: 1970 to 1981*, U.S. Government Printing Office, Washington, D.C., 1982; U.S. Bureau of the Census, 1980 Census of the Population Supplementary Report, PC80-S1-1, *Age, Sex, Race, and Spanish Origin of the Population by Regions, Divisions, and States: 1980*, U.S. Superintendent of Documents, Washington, D.C.

[c] "College freshmen" refers to first-time and full-time freshmen in college.

Table 21

PERCENT ASIAN-AMERICAN AT POINTS IN THE EDUCATIONAL PIPELINE[a] RELATIVE TO THE PERCENT ASIAN-AMERICAN OF AGE-RELEVANT POPULATION[b] BY YEAR (1970 TO 1980)

Year	Percent Asian-American					
	High School Graduates	College Freshmen[d]	B.A. Degrees	M.A. Degrees	Professional Degrees	Ph.D. Degrees
[Percent of 1970 age-relevant population]	[18 year olds: 0.6]		[22 year olds: 0.7]	[25-29 year olds: 0.8]		[30-34 year olds: 0.9]
[Percent of 1980 age-relevant population]	[18 year olds: 1.4]		[22 year olds: 1.5]	[25-29 year olds: 1.9]		[30-34 year olds: 2.1]
1970	NA	NA				
1971	NA	0.5				
1972	NA	1.1				
1973	NA	1.1				
1974	NA	0.9	0.9			
1975	NA	1.5				
1976	NA	2.0	1.2	1.4	1.5	2.0
1977	NA	1.1	1.5	1.7	1.6	2.2
1978	NA	1.0				
1979	NA	1.4	1.7	2.0	1.8	2.8
1980	NA	1.3				4.0

[a]Sources: The percent Asian-American for B.A., M.A., Ph.D. and professional degrees comes from Tables 10 to 13. The percent Asian American for college freshmen comes from the Cooperative Institutional Research Program at the University of California Los Angeles, *The American Freshman: National Norms* series from 1971 to 1980.

[b]U.S. Bureau of the Census, Current Population Reports, Series P-25, No. 917, *Preliminary Estimates of the Population of the United States by Age, Sex, and Race: 1970 to 1981*, U.S. Government Printing Office, Washington, D.C., 1982; U.S. Bureau of the Census, 1980 Census of the Population Supplementary Report, PC80-S1-1, *Age, Sex, Race, and Spanish Origin of the Population by Regions, Divisions, and States: 1980*. U.S. Superintendent of Documents; U.S. Bureau of the Census, *Census of the Population: 1970*. Subject Reports, No. PC(2)-1G, Japanese, Chinese, and Filipinos in the United States, U.S. Government Printing Office, Washington, D.C., 1973.

[c]There was substantial Asian immigration into the United States from 1970 to 1980. However, we have no population estimates for this group between the 1970 and 1980 decennial censuses. Therefore, we can only give percent of age-relevant groups fo[illegible] two points in time.

[illegible]lege freshmen" refers to first-time and full-time freshmen in college.

Table 22

PERCENT FEMALE AT POINTS IN THE EDUCATIONAL PIPELINE[a] RELATIVE TO THE PERCENT FEMALE OF AGE-RELEVANT POPULATION[b] BY YEAR (1970 TO 1980)

Year	Percent Female					
	High School Graduates	College Freshmen[c]	B.A. Degrees	M.A. Degrees	Professional Degrees	Ph.D. Degrees
[Percent female of age-relevant population, all years]	[18 year olds: 49.3]		[22 year olds: 49.8]	[25-29 year olds: 50.2]		[30-34 year olds: 50.6]
1970	51	45	43	40	5	13
1971	52	46	43	40	8	14
1972	52	46	44	41	8	16
1973	52	47	44	41	9	18
1974	52	48	44	43	12	19
1975	53	47	45	45	15	21
1976	52	48	45	46	18	23
1977	53	49	46	47	20	24
1978	53	51	47	48	23	26
1979	53	51	48	49	25	28
1980	51	52	49	49	27	30

[a]Sources: The percent female for B.A., M.A., Ph.D. and professional degrees comes from Tables 15 and 16. The percent female for high school graduates comes from the National Center for Educational Statistics, *Digest of Educational Statistics* series, 1971-1982. The percent female for college freshmen comes from the Cooperative Institutional Research Program at the University of California Los Angeles, *The American Freshman: National Norms* series from 1971 to 1980.

[b]Source: U.S. Bureau of the Census, Current Population Reports, Series P-25, No. 917, *Preliminary Estimates of the Population of the United States by Age, Sex, and Race: 1970 to 1981*, U.S. Government Printing Office, Washington, D.C., 1982.

[c]"College Freshmen" refers to first-time and full-time freshmen in college.

Their losses from the educational pipeline subsequent to high school changed across time. Up to 1979 they had higher losses than men from high school to college entry. Their losses from college entry to the B.A. degree were only slightly higher than men's and stable across the decade. For most of the decade their losses from the B.A. to M.A. degree were lower than men's and increasingly lower as the decade progressed. Their losses from the B.A. to a professional degree--and probably to the Ph.D. degree--were higher than men's but decreasingly so across the decade.

In sum, the underrepresentation of blacks, Hispanics, American Indians, and women among quantitative Ph.D. degrees is partly attributable to their underrepresentation at the Ph.D. level itself. Interventions that increase retention in the educational process itself should therefore increase the representation of these groups among quantitatively-based Ph.D.'s. However, the groups have different patterns of pipeline losses that precede their ultimate underrepresentation at the Ph.D. level. These different loss patterns imply that subgroups differ in their needs at different points in the pipeline. For blacks the losses are dispersed across the pipeline. For Hispanics, they are concentrated earlier in the pipeline (high school graduation and college entry points). For American Indians they occur at least between college entry and the B.A. degree. If we had adequate data for this subgroup, we probably would also find disproportionately high losses at high school graduation and college entry. However, this subgroup does *not* show disproportionately high losses after the B.A. degree. For women the losses are concentrated at the end of the pipeline (from B.A. to Ph.D.), but decreasingly so.

FIELD CHOICES

This section describes subgroups' field choices, *given* a particular level of educational attainment. It completes our attempt to separate persistence from field effects on subgroup shares of quantitative Ph.D. degrees.

Minority Field Choices

Associate degrees. Associate degree fields are relevant to the Ph.D. issue in two ways. Theoretically, the arts and sciences curriculum at the associate level parallels the first two years of the B.A. degree. Thus, we can regard the percent of each subgroup with an associate degree in this major as an *upper* limit on the percent of the group's associate degree graduates that might transfer into a B.A. track. Table 23 shows that about a third of all racial and ethnic groups (and men and women) select this field.[5] Hispanics and American Indians select it somewhat more frequently than the other racial and ethnic groups, but the differences are not large.

Occupational curricula at the associate level also vary in their science orientation. If a subgroup underrepresented among quantitatively-based Ph.D. degrees over-chooses scientific associate degree curricula, we might expect their percent in the more scientifically-based B.A., M.A., and Ph.D. degrees to increase as their educational attainment increases. Unfortunately, curricular categories encompass mixed collections of subfields.[6] It is therefore not clear which curricula might presage an increase in quantitative degrees as educational attainment itself increases.

B.A. degrees. Table 24 shows that about 16 percent, or 1.6 out of every 10 B.A. students, choose quantitative fields. Asian-Americans choose them at almost twice the national average; whites and Hispanics, at about the national average; American Indians, at about 80 percent of the national average; and blacks, at about 60 percent of the national average, or at the rate of 1 out of every 10 B.A. students.

These data indicate that Hispanic and American Indian underrepresentation among the quantitative B.A. degrees is primarily attributable to higher losses from the pipeline, not to field choice. For blacks

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[5] We report field choices for 1978/79 only because calculations for all three years (1975/76, 1976/77, and 1979/80) showed little difference across time for the racial and ethnic groups.

[6] For example, the natural science category includes agriculture, food services, home economics, general natural sciences, marine and oceanographic sciences.

Table 23

1978/79 DISTRIBUTION OF ASSOCIATE DEGREE GRADUATES BY FIELD, RACE AND ETHNICITY, AND SEX[a]

Racial and Ethnic Group and Sex	Total Associate Degrees	Field							
		Total	Business and Commerce	Data Processing Technologies	Health and Para-Medical Technologies	Mechanical and Engineering Technologies	Natural Science Technologies	Public Service Technologies	Arts & Sciences and General Programs
Total	505,015	100.0	22.7	2.3	17.7	13.7	3.9	7.4	31.4
Whites	415,818	100.0	22.4	2.2	18.7	13.9	4.3	7.2	31.4
Blacks	45,762	100.0	26.6	2.9	14.7	12.0	2.1	10.1	31.7
Hispanics	25,960	100.0	25.6	2.9	12.4	12.6	1.6	7.7	36.9
American Indians	3,073	100.0	19.1	1.8	16.0	15.5	3.8	8.6	35.2
Asian Americans	9,402	100.0	22.8	3.8	11.4	18.9	3.5	6.3	33.1
Women	268,163	100.0	26.7	2.1	29.2	1.6	2.8	6.6	30.8
Men	231,852	100.0	18.3	2.6	4.6	27.9	5.2	8.4	32.9

[a]Source: Department of Education, Office for Civil Rights, *Data on Earned Degrees Conferred by Institutions of Higher Education by Race, Ethnicity, and Sex, Academic Year 1978-1979*, 1981.

Table 24

TRENDS IN DISTRIBUTION OF B.A. GRADUATES BY FIELD, SEX, RACE AND ETHNICITY (1973/4 TO 1978/79)[a]

					Fields (Percent)									
					Quantitatively-Based Disciplines									
Sex	Racial and Ethnic Group	Year	Total B.A.s	Total	Total	Physical Sciences	Mathematics	Computer Sciences	Biological Sciences	Engineering	Social Sciences	Business	Education	All Other
Total	Total	1973/74	989,200	100.0	11	3	3	NA	5	6	21	14	18	31
		1975/76	912,000	100.0	15	2	2	0.6	6	5	19	15	17	33
		1976/77	899,428	100.0	16	2	2	0.7	6	5	18	17	16	33
		1978/79	911,637	100.0	16	2	1	0.9	5	6	16	19	14	34
	Whites	1973/74	912,300	100.0	17	3	3	NA	5	6	21	14	18	30
		1975/76	811,772	100.0	16	2	2	0.5	6	5	19	15	17	34
		1976/77	805,186	100.0	17	3	2	0.7	6	5	18	16	16	33
		1978/79	802,665	100.0	17	3	1	0.9	5	7	16	19	14	35
	Blacks	1973/74	52,100	100.0	9	1	2	NA	4	2	27	13	27	24
		1975/76	59,187	100.0	9	1	1	0.6	4	2	24	16	24	27
		1976/77	58,515	100.0	9	1	1	0.6	4	2	23	17	22	29
		1978/79	60,301	100.0	10	1	1	0.8	4	3	20	19	19	31
	Hispanics	1973/74	12,800	100.0	15	3	1	NA	4	7	23	12	16	34
		1975/76	26,220	100.0	19	1	1	0.4	6	5	22	15	17	32
		1976/77	18,663	100.0	14	2	1	0.5	5	5	23	14	16	33
		1978/79	28,719	100.0	15	2	1	0.7	6	5	19	19	16	31
	American Indians	1973/74	2,800	100.0	14	2	1	NA	3	8	23	14	17	32
		1975/76	3,496	100.0	12	2	2	0.2	4	4	20	12	21	35
		1976/77	3,319	100.0	12	2	1	0.5	5	4	19	13	21	34
		1978/79	3,410	100.0	13	2	1	0.3	4	5	20	15	19	34
	Asian-Americans	1973/74	9,300	100.0	28	3	5	NA	10	10	20	18	7	27
		1975/76	11,323	100.0	26	3	3	1.1	11	9	18	16	7	32
		1976/77	13,745	100.0	24	3	2	1.2	10	9	18	19	7	32
		1978/79	15,542	100.0	28	3	2	1.7	9	12	15	21	5	31
Males	Whites	1975/76	444,768	100.0	22	4	2	0.9	7	8	20	23	8	27
		1978/79	418,271	100.0	24	4	1	1.3	6	12	16	26	7	27
	Blacks	1975/76	25,660	100.0	14	2	1	0.8	5	5	27	23	14	22
		1978/79	24,675	100.0	15	2	1	1.1	5	6	22	25	12	26
	Hispanics	1975/76	13,594	100.0	19	2	2	0.6	6	9	24	22	10	25
		1978/79	14,331	100.0	21	2	1	1.0	7	10	20	25	10	24

Sex	Racial and Ethnic Group	Year	Total B.A.s	Total	Fields (Percent): Quantitatively-Based Disciplines: Total	Physical Sciences	Mathematics	Computer Sciences	Biological Sciences	Engineering	Social Sciences	Business	Education	All Other
	American Indians	1975/76	1,916	100.0	18	3	2	0.3	5	8	21	18	12	31
		1978/79	1,736	100.0	19	3	2	0.6	6	9	21	20	11	29
	Asian-Americans	1975/76	6,359	100.0	30	4	3	1.4	7	15	17	21	5	28
		1978/79	8,319	100.0	38	4	2	2.1	10	20	14	23	4	22
Females	Whites	1975/76	367,004	100.0	8	1.0	1.6	0.1	4.5	0.1	17	6	27	42
		1978/79	384,394	100.0	8	1.2	1.1	0.5	4.4	1.2	16	11	21	44
	Blacks	1975/76	33,527	100.0	6	0.6	1.3	0.4	3.5	0.2	22	11	31	30
		1978/79	35,626	100.0	7	0.8	0.9	0.7	3.8	0.6	19	15	24	35
	Hispanics	1975/76	12,626	100.0	8	0.7	1.1	0.2	5.3	0.4	20	8	26	40
		1978/79	15,383	100.0	9	0.9	0.9	0.4	5.7	0.8	18	13	22	38
	American Indians	1975/76	1,572	100.0	5	0.4	0.9	0.1	3.4	0.1	19	5	32	39
		1978/79	1,674	100.0	6	1.1	0.8	0	3.1	0.7	19	10	27	39
	Asian-Americans	1975/76	4,964	100.0	21	1.5	2.7	0.7	15.3	1.0	19	11	11	38
		1978/79	7,223	100.0	17	1.7	2.1	1.3	8.9	3.0	[illegible]	18	7	41

[a]Sources: Data for 1973/74 come from the American Council on Education, *A Fact Book on Higher Education*, #4, 1976, Table 76.225. Data for 1975/76 come from the Department of Health, Education, and Welfare, Office for Civil Rights, *Data on Earned Degrees Conferred from Institutions of Higher Education by Race, Ethnicity, and Sex, Academic Year 1975-76*, 1978. Data for 1976/77 come from the Department of Education, National Center for Educational Statistics, *Digest of Educational Statistics*, 1980, Table 111. Data for 1978/79 come from the Department of Education, Office for Civil Rights, *Data on Earned Degrees Conferred by Institutions of Higher Education by Race, Ethnicity, and Sex, Academic Year 1978-1979*, 1981.

both pipeline losses and field choices contribute to their underrepresentation among quantitative B.A. degrees.

M.A. degrees. As Table 25 shows, at the M.A. level 1 out of every 10 M.A. students chooses a quantitative field, a smaller ratio than at either the B.A. or Ph.D. levels. At this level Asian-Americans choose quantitative fields at more than double the national average; whites and American Indians, at about the national average; Hispanics, at 80 percent of the national average; and blacks, at 40 percent of the national average.

We can conclude that for American Indians their greater attrition prior to the M.A. degree, not field choice at the M.A. level itself, is responsible for their underrepresentation among quantitative M.A. degrees. Field choice contributes to Hispanics' underrepresentation, but disproportionately high attrition prior to the M.A. level has more effect. For blacks both pipeline attrition and field choice at the M.A. level contribute to their underrepresentation among quantitative M.A. degrees.

Ph.D. degrees. Of all U.S. citizens who earn Ph.D. degrees, 3 out of every 10 choose quantitative fields (Table 26). Asian-Americans again choose them at twice the national average. In 1979/80, for example, 6 out of every 10 Asian-American Ph.D. graduates earned their degrees in quantitative fields. White Ph.D. graduates choose them at the national average; Hispanics and American Indians, at about two-thirds of the national average; and blacks, at about a third of the national average, or at 1 out of every 10 Ph.D. degrees.

Thus, black, Hispanic, and American Indian underrepresentation among quantitatively-based Ph.D. degrees is attributable to attrition from the pipeline and field choice effects. Blacks lose "field" ground just as they lose attainment ground: at several points in the process. The percent choosing quantitative fields decreases across degree levels: at the B.A. level, 60 percent of the national average; at the M.A. level, 40 percent of the national average; and at the Ph.D. level, 33 percent of the national average.

Professional degrees. At the professional degree level about 4 out of every 10 members of each racial and ethnic subgroup except the Asian-Americans choose physically-/biologically-based fields (Table 27). Of the Asian-Americans, about 6 out of every 10 choose these fields.

Table 25

TRENDS IN DISTRIBUTION OF M.A. GRADUATES BY FIELD, SEX, RACE AND ETHNICITY (1975/76 TO 1978/79)[a]

					Fields (Percent)									
					Quantitatively-Based Disciplines									
Sex	Racial and Ethnic Group	Year	Total M.A.s	Total	Total	Physical Sciences	Mathematics	Computer Sciences	Biological Sciences	Engineering	Social Sciences	Business	Education	All Other
Total	Total	1975/76	294,390	100.0	10	2	1	0.8	2	4	8	13	43	26
		1976/77	298,322	100.0	10	2	1	0.8	2	4	7	14	42	27
		1978/79	281,465	100.0	10	2	1	0.9	2	4	7	16	39	28
	Whites	1975/76	262,851	100.0	10	2	1	0.8	2	4	8	14	42	27
		1976/77	265,147	100.0	10	2	1	0.8	2	4	7	15	40	28
		1978/79	249,092	100.0	10	2	1	0.9	2	4	7	17	38	29
	Blacks	1975/76	20,351	100.0	4	1	1	0.3	1	1	6	8	61	21
		1976/77	21,024	100.0	4	0.4	1	0.3	1	1	7	8	60	21
		1978/79	19,397	100.0	4	0.4	0.4	0.3	1	1	6	11	56	23
	Hispanics	1975/76	6,356	100.0	7	1	1	0.3	1	4	8	9	44	31
		1976/77	6,369	100.0	8	1	1	1.2	1	4	11	9	44	28
		1978/79	6,459	100.0	7	1	1	0.4	2	3	7	12	43	31
	American Indians	1975/76	795	100.0	10	1	1	0.9	2	5	7	9	49	25
		1976/77	967	100.0	7	2	1	0.3	2	2	6	11	50	26
		1978/89	999	100.0	9	3	1	1.6	2	2	7	14	45	26
	Asian-Americans	1975/76	4,037	100.0	23	3	2	1.6	3	12	7	18	23	28
		1976/77	5,115	100.0	24	3	2	2.1	3	14	8	18	19	32
		1978/79	5,518	100.0	27	3	2	2.7	4	15	6	23	17	28
Males	Whites	1975/76	139,539	100.0	16	3	2	1.3	3	8	9	23	28	24
		1978/79	123,776	100.0	16	3	1	1.5	3	7	8	27	24	25
	Blacks	1975/76	7,809	100.0	7	1	1	0.7	1	3	9	16	47	22
		1978/79	7,046	100.0	7	1	1	0.6	1	3	9	22	39	24
	Hispanics	1975/76	3,305	100.0	12	2	1	0.4	2	7	10	16	35	28
		1978/79	3,141	100.0	11	2	1	0.4	2	6	9	19	33	27
	American Indians	1975/76	432	100.0	16	2	1	1.6	2	9	7	15	39	23
		1978/79	495	100.0	14	5	1	1.2	2	4	5	22	13	25
	Asian-Americans	1975/76	2,499	100.0	31	4	3	2.0	3	19	8	24	14	23
		1978/79	3,330	100.0	37	4	2	3.5	3	24	6	29	9	19

Table 25 (continued)

Sex	Racial and Ethnic Group	Year	Total M.A.s	Total	Fields (Percent): Quantitatively-Based Disciplines: Total	Physical Sciences	Mathematics	Computer Sciences	Biological Sciences	Engineering	Social Sciences	Business	Education	All Other
Females	Whites	1975/76	123,312	100.0	3	0.5	0.9	0.2	1.4	0.3	6	3	57	30
		1978/79	125,316	100.0	4	0.7	0.7	0.4	1.7	0.6	6	6	52	32
	Blacks	1975/76	12,542	100.0	2	0.3	0.5	0.1	0.8	0.2	5	3	70	21
		1978/79	12,351	100.0	2	0.2	0.3	0.2	1.0	0.2	5	5	66	23
	Hispanics	1975/76	3,051	100.0	3	0.7	0.6	0.1	1.1	0.3	6	2	54	35
		1978/79	3,318	100.0	3	0.4	0.4	0.3	1.6	0.3	5	4	53	34
	American Indians	1975/76	363	100.0	2	0.0	0.8	0.0	1.7	0	6	2	88	1
		1978/79	504	100.0	5	0.6	0.4	2.0	1.6	0.4	8	5	57	26
	Asian-Americans	1975/76	1,538	100.0	10	1.9	1.6	1.0	3.3	2.0	7	8	39	36
		1978/79	2,188	100.0	11	1.4	1.7	1.6	4.2	2.2	5	12	31	41

[a]Sources: Data for 1975/76 come from the Department of Health, Education, and Welfare, Office for Civil Rights, *Data on Earned Degrees Conferred from Institutions of Higher Education by Race, Ethnicity, and Sex, Academic Year 1975-76*, 1978. Data for 1976/77 come from the Department of Education, National Center for Educational Statistics, *Digest of Educational Statistics*, 1980, Table 111. Data for 1978/79 come from the Department of Education, Office for Civil Rights, *Data on Earned Degrees Conferred by Institutions of Higher Education by Race, Ethnicity, and Sex, Academic Year 1978-1979*, 1981.

Table 26

TRENDS IN DISTRIBUTION OF Ph.D. GRADUATES BY FIELD, SEX, RACE AND ETHNICITY (1975/76 TO 1979/80)[a]

				Fields (Percent)										
					Quantitatively-Based Disciplines									
Sex	Racial and Ethnic Group	Year	Total Ph.D.s	Total	Total	Physical Sciences	Mathematics	Computer Sciences	Biological Sciences	Engineering	Social Sciences	Business	Education	All Other
Total	Total	1975/76	29,731	100.0	29	10	2	0.7	10	6	20	3	25	23
		1976/77	29,364	100.0	29	10	2	0.6	10	6	20	2	26	23
		1978/79	28,774	100.0	29	9	2	0.7	11	6	19	2	25	25
		1979/80	27,350	100.0	31	10	2	0.6	12	6	21	b	26	18
	Whites	1975/76	27,435	100.0	29	10	2	0.7	10	6	21	3	24	23
		1976/77	26,836	100.0	30	10	2	0.6	11	6	21	2	25	22
		1978/79	26,138	100.0	29	9	2	0.7	11	5	19	3	24	25
		1979/80	24,569	100.0	29	10	2	0.7	12	5	21	b	25	22
	Blacks	1975/76	1,213	100.0	10	3	1	0.0	4	2	15	1	55	18
		1976/77	1,253	100.0	11	4	1	0.1	2	2	18	1	55	15
		1978/79	1,268	100.0	11	4	1	0.3	4	2	19	1	49	19
		1979/80	1,095	100.0	9	2	1	0.0	4	2	20	b	55	24
	Hispanics	1975/76	406	100.0	21	7	3	0.3	6	4	20	2	34	23
		1976/77	522	100.0	21	7	3	0.0	5	5	22	1	31	25
		1978/79	453	100.0	19	6	1	0.2	8	5	23	1	30	27
		1979/80	[illegible]	100.0	19	6	1	0.2	6	6	22	b	32	16
	American Indians	1975/76	[illegible]	100.0	18	9	1	0.3	4	3	13	6	38	25
		1976/77	[illegible]	100.0	28	6	3	1.1	16	2	17	3	34	18
		1978/79	104	100.0	15	8	0	0.0	6	2	26	3	41	14
		1979/80	106	100.0	19	7	0	0.0	9	3	17	b	50	27
	Asian-Americans	1975/76	[illegible]	100.0	55	15	4	0.7	15	20	12	3	10	19
		1976/77	658	100.0	56	14	4	1.4	16	19	15	2	12	17
		1978/79	811	100.0	58	15	4	1.0	16	23	11	1	12	18
		1979/80	1,097	100.0	61	17	4	0.8	14	25	13	b	8	18
Males	Whites	1975/76	20,853	100.0	34	12	3	0.8	11	8	20	3	21	22
		1978/79	18,433	100.0	34	12	2	0.8	12	7	18	3	20	24
	Blacks	1975/76	771	100.0	13	5	1	0.0	5	2	17	2	50	18
		1978/79	734	100.0	14	6	2	0.4	3	3	19	2	42	22
	Hispanics	1975/76	294	100.0	24	8	4	0.3	6	5	23	3	30	20
		1978/79	302	100.0	24	7	2	0.3	8	7	22	1	28	25

				Fields (Percent)											
					Quantitatively-Based Disciplines										
Sex	Racial and Ethnic Group	Year	Total Ph.D.s	Total	Total	Physical Sciences	Mathematics	Computer Sciences	Biological Sciences	Engineering	Social Sciences	Business	Education	All Other
	American Indians	1975/76	77	100.0	22	10	1	1.3	5	4	14	8	35	21
		1978/79	69	100.0	22	10	0	0.0	9	3	26	3	36	13
	Asian-Americans	1975/76	480	100.0	59	15	4	0.8	14	24	12	4	8	18
		1978/79	646	100.0	61	15	3	1.2	14	28	10	2	9	17
Females	Whites	1975/76	6,582	100.0	15	3	1.1	0.3	9	0.8	23	1	32	21
		1978/79	7,705	100.0	15	3	1.2	0.4	10	0.7	22	1	35	27
	Blacks	1975/76	442	100.0	5	1	0.2	0	4	0.0	12	0	64	18
		1978/79	534	100.0	6	1	0.2	0.2	4	0.4	19	0.4	59	16
	Hispanics	1975/76	113	100.0	14	6	0.9	0	6	0.9	12	0	43	30
		1978/79	151	100.0	11	3	0.7	0	7	0.7	25	1	33	30
	American Indians	1975/76	16	100.0	0	0	0	0	0	0	6	0	50	44
		1978/79	35	100.0	3	3	0	0	0	0	26	3	51	17
	Asian-Americans	1975/76	103	100.0	40	14	2.9	0	21	1.9	13	0	22	25
		1978/79	165	100.0	43	13	4.9	0	24	1.8	15	0	22	20

[a]Data for 1975/76 come from the Department of Health, Education, and Welfare, Office for Civil Rights, *Data on Earned Degrees Conferred from Institutions of Higher Education by Race, Ethnicity, and Sex, Academic Year 1975-76*. Data for 1976/77 come from the Department of Education, National Center for Educational Statistics, *Digest of Educational Statistics*, 1980, Table 111. Data for 1978/79 come from the Department of Education, Office for Civil Rights, *Data on Earned Degrees Conferred by Institutions of Higher Education by Race, Ethnicity, and Sex, Academic Year 1978-1979*, 1981. Data for 1979/80 come from the National Academy of Sciences and National Science Foundation, *Summary Report 1980, Doctorate Recipients from United States Universities*, 1980.

[b]The data source for 1979/80 includes business in all other fields.

Table 27

TRENDS IN PROFESSIONAL DEGREE GRADUATES BY FIELD, SEX, RACE AND ETHNICITY (1975/76 TO 1978/79)[a]

Sex	Racial and Ethnic Group	Year	All Professional Degrees	Fields (Percent) Total	Medicine	Law	Other Physically- or Biologically-Based Fields[b]	Other non-Physically- or Biologically-Based Fields[c]
Total	Total	1975/76	60,161	100.0	22	54	16	8
		1976/77	63,252	100.0	21	54	17	8
		1978/79	66,679	100.0	22	53	16	9
	Whites	1975/76	54,989	100.0	22	54	16	9
		1976/77	58,422	100.0	21	54	17	9
		1978/79	60,819	100.0	22	53	16	9
	Blacks	1975/76	2,667	100.0	27	57	9	8
		1976/77	2,537	100.0	28	53	11	8
		1978/79	2,829	100.0	27	53	10	10
	Hispanics	1975/76	1,404	100.0	22	61	12	5
		1976/77	1,076	100.0	21	62	10	6
		1978/79	1,636	100.0	28	55	11	5
	American Indians	1975/76	[illegible]	100.0	[illegible]	[illegible]	20	[illegible]
		1976/77	196	100.0	15	62	20	3
		1978/79	210	100.0	18	58	22	[illegible]
	Asian-Americans	1975/76	904	100.0	25	35	35	5
		1976/77	1,021	100.0	26	38	31	5
		1978/79	1,185	100.0	31	33	32	4
Males	Whites	1975/76	[illegible]	100.0	22	51	17	[illegible]
		1976/77	47,777	100.0	21	51	19	9
		1978/79	46,677	100.0	22	50	17	11
	Blacks	1975/76	1,992	100.0	25	55	10	9
		1976/77	1,761	100.0	27	51	12	10
		1978/79	1,778	100.0	28	48	10	14
	Hispanics	1975/76	1,155	100.0	21	60	13	6
		1976/77	893	100.0	21	62	11	6
		1978/79	1,223	100.0	27	54	12	6
	American Indians	1975/76	[illegible]	100.0	20	34	23	[illegible]
		1976/77	159	100.0	16	60	21	3
		1978/79	145	100.0	17	55	25	3
	Asian-Americans	1975/76	699	100.0	25	33	36	6
		1976/77	776	100.0	28	34	33	5
		1978/79	842	100.0	31	30	34	5
Females	Whites	1975/76	8,386	100.0	22	66	8	5
		1976/77	10,645	100.0	21	65	10	5
		1978/79	14,142	100.0	21	64	10	6
	Blacks	1975/76	675	100.0	30	62	5	3
		1976/77	776	100.0	31	57	9	3
		1978/79	1,051	100.0	26	61	9	4

Table 27 (continued)

Sex	Racial and Ethnic Group	Year	All Professional Degrees	Total	Fields (Percent) Medicine	Law	Other Physically- or Biologically-Based Fields[b]	Other non-Physically- or Biologically-Based Fields[c]
	Hispanics	1975/76	249	100.0	24	65	8	4
		1976/77	183	100.0	24	67	7	3
		1978/79	409	100.0	31	59	8	1
	American Indians	1975/76	29	100.0	38	55	3	3
		1976/77	37	100.0	14	73	14	0
		1978/79	65	100.0	20	63	17	0
	Asian-Americans	1975/76	205	100.0	24	40	33	2
		1976/77	245	100.0	20	53	24	3
		1978/79	343	100.0	31	41	27	1

[a]Sources: Data for 1975/76 come from the Department of Health, Education, and Welfare, Office for Civil Rights, *Data on Earned Degrees Conferred from Institutions of Higher Education by Race, Ethnicity, and Sex, Academic Year 1975-76*, 1978. Data for 1976/77 come from the Department of Education, National Center for Educational Statistics, *Digest of Educational Statistics*, 1980, Table 111. Data for 1978/79 come from the Department of Education, Office for Civil Rights, *Data on Earned Degrees Conferred by Institutions of Higher Education by Race, Ethnicity, and Sex, Academic Year 1978-1979*, 1981.

[b]Other physically- or biologically-based professional degrees include degrees in: dentistry, optometry, osteopathy, podiatry, veterinary medicine, and pharmacy.

[c]Other non-physically- or biologically-based professional degrees include degrees in theology only.

[1]A large number of male theology degrees in this year and the very small total number of American Indian professional degrees account for this peculiarly high percent.

Female Field Choices

Among *B.A. degree* graduates (Table 28), somewhat under 20 percent[6] choose quantitative fields. For the last decade 3 out of every 10 men chose these fields; one out of every 10 women. Thus, the increase in the female percent of quantitative B.A. degrees is essentially attributable to the increased percent of women who obtain the B.A. degree itself, not to an increase in the percent choosing a quantitative field.

At the *M.A. level* (Table 29), 1.2 of every 10 M.A. students in 1979/80 chose quantitative M.A. fields, as opposed to 1.7 of every 10 M.A. students in 1969/70--a 30 percent decline. Both male and female students chose quantitative fields at lower rates, the decline for males

[6] Tables 28-31 show slightly higher percents in the quantitatively-based disciplines than the racial and ethnic tables because they include economics in the quantitative field totals. Reports of field data by race and ethnicity subsumed economics in a general social science category.

Table 28

TRENDS IN THE DISTRIBUTION OF MALE AND FEMALE B.A. GRADUATES BY FIELD (1969/70 TO 1979/80)

Sex	Year	Total B.A.s	Fields (Percent) Total	Quantitatively-Based Disciplines Total	Physical Sciences	Mathematics	Computer Sciences	Biological Sciences	Engineering	Economics	Social Sciences	Business	Education	All Other
Total	1969/70	792,316	100.0	19	3	3	0.2	5	6	2	16	13	21	31
	1970/71	839,730	100.0	18	3	3	0.3	4	6	2	16	14	21	32
	1971/72	887,273	100.0	17	2	3	0.4	4	6	2	16	14	22	32
	1972/73	922,362	100.0	17	2	3	0.5	5	6	2	16	14	21	32
	1973/74	945,776	100.0	17	2	2	0.5	5	5	2	16	14	20	33
	1974/75	922,933	100.0	17	2	2	0.6	6	5	2	15	14	18	35
	1975/76	925,746	100.0	17	2	2	0.6	6	5	2	14	15	17	36
	1976/77	919,549	100.0	18	2	2	0.7	6	5	2	13	17	16	37
	1977/78	921,204	100.0	18	3	1	0.6	6	6	2	13	18	15	37
	1978/79	921,390	100.0	19	3	1	1.0	5	7	2	12	19	14	37
	1979/80	940,251	100.0	19	3	1	1.2	5	7	2	12	20	13	36
Male	1969/70	451,097	100.0	27	4	4	0.3	6	10	3	16	21	9	26
	1970/71	475,594	100.0	26	4	3	0.4	4	6	2	16	14	21	32
	1971/72	500,590	100.0	25	4	3	0.6	5	10	3	16	22	10	27
	1972/73	518,191	100.0	25	3	3	0.7	6	10	2	16	22	10	27
	1973/74	527,313	100.0	25	3	2	0.8	6	9	2	16	22	9	28
	1974/75	504,841	100.0	25	3	2	0.8	7	9	2	15	22	9	29
	1975/76	504,925	100.0	24	3	2	0.9	7	9	2	14	23	8	30
	1976/77	495,545	100.0	25	4	2	1.0	7	10	2	13	24	8	31
	1977/78	487,347	100.0	26	4	2	0.9	7	11	2	12	24	8	30
	1978/79	477,344	100.0	27	4	1	1.3	6	12	2	11	25	7	29
	1979/80	477,750	100.0	28	4	1	1.6	6	13	3	10	26	7	28
Female	1969/70	341,219	100.0	8	1	3	0.6	3	0.1	0.5	16	3	36	37
	1970/71	364,136	100.0	7	1	3	0.1	3	0.1	0.5	16	3	36	39
	1971/72	386,683	100.0	7	1	2	0.2	3	0.1	0.5	16	3	37	38
	1972/73	404,171	100.0	7	1	2	0.2	3	0.2	0.5	16	3	35	39
	1973/74	418,463	100.0	7	1	2	0.2	4	0.2	0.5	16	4	33	40
	1974/75	418,092	100.0	8	1	2	0.2	4	0.2	0.6	15	5	29	42
	1975/76	420,821	100.0	8	1	2	0.3	4	0.4	0.7	15	7	27	43
	1976/77	424,004	100.0	9	1	1	0.4	5	0.5	0.8	14	8	24	44
	1977/78	433,857	100.0	9	1	1	0.4	5	0.9	0.9	14	10	23	44
	1978/79	444,046	100.0	9	1	1	0.6	4	0.1	1.0	13	12	21	45
	1978/80	462,501	100.0	10	1	1	0.7	4	1.4	1.2	13	14	19	44

Source: National Center for Educational Statistics. *Digest of Educational Statistics* series, 1971-1981, Department of Health, Education, and Welfare, and Department of Education. The data reported in the *Digest* come from the National Center's *Earned Degrees Conferred* data series for 1969-70 to 1979-80.

TABLE 29

TRENDS IN THE DISTRIBUTION OF MALE AND FEMALE M.A. GRADUATES BY FIELD (1969/70 TO 1979/80)

				FIELDS (Percent)										
				Quantitatively-Based Disciplines										
Sex	Year	Total M.A.s	Total	Total	Physical Sciences	Mathematics	Computer Sciences	Biological Sciences	Engineering	Economics	Social Sciences	Business	Education	All Other
Total	1969/70	208,291	100.0	17	3	3	1	3	7	1	10	10	38	24
	1970/71	230,509	100.0	16	3	2	1	2	7	1	6	12	38	28
	1971/72	251,633	100.0	15	2	2	1	2	7	1	6	12	39	28
	1972/73	2[illegible],371	100.0	15	2	2	1	2	6	1	6	12	40	28
	1973/74	277,033	100.0	13	2	2	1	2	6	1	6	12	41	28
	1974/75	292,450	100.0	12	2	1	1	2	5	1	6	12	4[illegible]	28
	1975/76	311,771	100.0	12	2	1	1	2	5	1	6	14	4[illegible]	28
	1976/77	317,164	100.0	12	2	1	1	2	5	1	6	15	40	28
	1977/78	311,620	100.0	12	2	1	1	2	5	1	6	16	38	29
	1978/79	[illegible]01,079	100.0	12	2	1	1	2	5	1	5	17	37	29
	1979/80	299,095	100.0	12	2	1	1	2	5	1	5	19	35	29
Male	1969/70	125,624	100.0	25	4	3	1	3	12	1	10	16	28	20
	1970/71	138,146	100.0	23	4	3	1	3	[illegible]	1	7	18	28	23
	1971/72	149,550	100.0	22	4	2	1	3	11	1	7	20	28	23
	1972/73	15[illegible],468	100.0	22	4	2	1	3	11	1	7	19	28	24
	1973/74	157,842	100.0	20	3	2	1	3	10	1	7	19	29	25
	1974/75	161,570	100.0	19	3	2	1	3	9	1	7	21	28	25
	1975/76	167,248	100.0	19	3	2	1	3	9	1	6	23	27	25
	1976/77	167,783	100.0	19	3	1	1	3	9	1	6	24	26	26
	1977/78	[illegible],212	100.0	19	3	1	2	3	10	1	6	25	24	26
	1978/79	153,370	100.0	19	3	1	2	3	9	1	6	27	23	26
	1979/80	151,159	100.0	20	3	1	2	3	10	1	5	28	20	26
Female	1969/70	82,667	100.0	6	1	2	0.7	2	0.2	0.3	10	1	53	30
	1970/71	92,363	100.0	5	1	2	0.2	2	0.2	0.3	5	1	43	35
	1971/72	102,083	100.0	5	1	2	0.2	2	0.3	0.3	5	1	55	34
	1972/73	108,903	100.0	5	1	1	0.2	2	0.3	0.3	5	1	56	33
	1973/74	119,191	100.0	5	1	1	0.2	2	0.3	0.3	5	2	56	21
	1974/75	130,880	100.0	4	1	1	0.3	1	0.3	0.2	5	2	57	32
	1975/76	144,523	100.0	4	1	1	0.3	1	0.4	[illegible].2	5	3	57	31
	1976/77	14[illegible],381	100.0	4	1	1	0.3	2	0.4	[illegible]	5	4	56	31
	1977/78	150,408	100.0	4	1	1	0.4	2	0.6	[illegible]	5	5	53	32
	1978/79	147,709	100.0	4	1	1	0.4	2	0.6	[illegible]	5	7	52	32
	1979/80	147,936	100.0	5	1	1	0.4	2	0.6	0.3	5	8	49	33

Source: National Center for Educational Statistics, *Digest of Educational Statistics* series, 1971-1981, Department of Health, Education, and Welfare, and Department of Education. The data reported in the *Digest* come from the National Center's *Earned Degrees Conferred* data series for 1969-70 to 1979-80.

Table 30

TRENDS IN THE DISTRIBUTION OF MALE AND FEMALE PH.D. GRADUATES BY FIELD (1969/70 TO 1979/80)

				Fields (Percent)									
				Quantitatively-Based Disciplines									
Sex	Year	Total Ph.D.s	Total	Total	Physical Sciences	Mathematics	Computer Sciences	Biological Sciences	Engineering	Economics	Social Sciences	Education	All Other
Total	1969/70	29,866	100.0	45	14	4	0.4	11	12	3	12	[illegible]	23
	1970/71	32,107	100.0	43	14	4	0.4	11	11	2	12	20	[illegible]
	1971/72	33,363	100.0	41	12	3	0.5	12	11	2	12	21	27
	1972/73	34,777	100.0	38	12	3	0.6	10	10	2	12	21	29
	1973/74	33,816	100.0	37	11	3	0.6	10	10	2	13	22	28
	1974/75	34,083	100.0	36	11	3	0.6	10	9	2	14	22	26
	1975/76	34,064	100.0	[illegible]	10	3	0.7	10	8	2	15	23	29
	1976/77	33,232	100.0	[illegible]	10	2	0.7	10	8	2	[illegible]	24	28
	1977/78	32,131	100.0	[illegible]	10	1	0.6	10	6	2	14	24	29
	1978/79	32,730	100.0	[illegible]	9	2	0.7	11	8	2	14	24	30
	1979/80	32,632	100.0	33	9	2	0.7	11	8	2	14	24	28
Male	1969/79	25,890	100.0	48	15	4	0.4	11	12	3	12	20	22
	1970/71	27,530	100.0	44	15	4	0.5	11	13	2	11	18	25
	1971/72	28,090	100.0	43	14	4	0.6	11	13	3	11	19	25
	1972/73	28,571	100.0	42	13	3	0.6	10	12	3	11	19	27
	1973/74	27,365	100.0	41	12	3	0.7	10	12	3	12	19	27
	1974/75	26,817	100.0	40	12	3	0.7	10	11	3	13	19	28
	1975/76	26,267	100.0	39	12	3	0.8	10	10	3	14	20	27
	1976/77	25,142	100.0	39	12	3	0.8	11	[illegible]	3	13	21	27
	1977/78	23,658	100.0	39	12	3	0.8	11	[illegible]	3	13	20	28
	1978/79	23,541	100.0	39	12	3	0.9	11	10	3	12	19	29
	1979/80	22,950	100.0	40	12	3	0.9	12	11	3	12	19	28
Female	1969/70	3,976	100.0	22	6	2	0.1	12	0.6	1	17	30	[illegible]
	1970/71	4,577	100.0	22	5	2	0.1	13	0.5	1	17	30	32
	1971/72	5,273	100.0	20	5	2	0.2	12	0.4	1	16	31	32
	1972/73	6,206	100.0	19	4	2	0.2	11	0.9	1	17	29	[illegible]
	1973/74	6,451	100.0	18	4	2	0.1	11	0.9	1	18	31	33
	1974/75	7,266	100.0	18	4	2	0.2	10	0.9	1	18	32	[illegible]
	1975/76	7,797	100.0	17	4	1	0.3	9	0.9	1	18	33	[illegible]
	1976/77	8,090	100.0	16	4	1	0.2	9	0.9	1	19	34	31
	1977/78	8,473	100.0	16	4	1	0.2	9	0.7	1	19	35	30
	1978/79	9,189	100.0	17	4	1	0.3	10	0.9	1	18	36	29
	1979/80	9,682	100.0	17	4	1	0.3	10	1.0	1	18	36	28

Source: National Center for Educational Statistics, *Digest of Educational Statistics* series, 1971-1981, Department of Health, Education and Welfare, and Department of Education. The data reported in the *Digest* come from the National Center's *Earned Degrees Conferred* data series for 1969-70 to 1979-80.

Table 31

TRENDS IN THE DISTRIBUTION OF MALE AND FEMALE PROFESSIONAL DEGREE GRADUATES BY FIELD (1969/70 TO 1979/80)[a]

Sex	Year	All Professional Degrees	Fields (Percent) Total	Medicine	Law	Other Physically- or Biologically-Based Fields[b]	Other Non-Physically- or Biologically-Based Fields[c]
Total	1969/70[d]	32,918	100.0	23	43	17	15
	1970/71	48,137	100.0	19	37	23	22
	1971/72	54,617	100.0	17	40	21	22
	1972/73	63,170	100.0	16	44	21	19
	1973/74	67,403	100.0	17	44	20	19
	1974/75	69,904	100.0	18	42	21	19
	1975/76	75,855	100.0	17	43	20	19
	1976/77	79,296	100.0	17	43	21	19
	1977/78	80,935	100.0	18	43	21	19
	1978/79	83,020	100.0	18	43	20	19
	1979/80	83,666	100.0	18	43	20	19
Male	1969/70[d]	31,077	100.0	23	43	15	16
	1970/71	44,106	100.0	18	37	22	22
	1971/72	50,062	100.0	17	41	20	22
	1972/73	57,395	100.0	16	44	20	19
	1973/74	[illegible]	100.0	17	44	19	19
	1974/75	59,738	100.0	18	42	21	19
	1975/76	62,458	100.0	18	42	20	20
	1976/77	63,135	100.0	17	42	21	20
	1977/78	62,172	100.0	18	41	21	20
	1978/79	[illegible]	100.0	19	41	20	[illegible]
	1979/80	61,297	100.0	19	41	20	21
Female	1969/70[d]	1,841	100.0	38	44	9	7
	1970/71	4,032	100.0	21	32	28	19
	1971/72	4,551	100.0	19	34	28	19
	1972/73	5,772	100.0	16	39	26	19
	1973/74	7,968	100.0	19	43	23	18
	1974/75	10,166	100.0	16	44	22	18
	1975/76	13,397	100.0	16	47	20	17
	1976/77	16,161	100.0	16	47	21	16
	1977/78	18,763	100.0	16	48	20	16
	1978/79	21,054	100.0	16	48	20	16
	1979/80	22,369	100.0	16	48	20	16

[a] Source: National Center for Education Statistics. *[illegible]* series, 1969-70 to 1979-80. Department of Health, Education, and Welfare and Department of Education.

[b] Other physically- or biologically-based professional degrees include degrees in dentistry, optometry, osteopathy, podiatry, veterinary medicine, and pharmacy.

[c] Other non-physically- or biologically-based professional degrees include degrees in theology, and architecture.

[d] In 1969/70 the data on professional degrees did not include architecture or pharmacy. In subsequent years these were relatively large categories, roughly equal in size, and with relatively high proportions of women. Their omission from the 1969/70 professional degrees skews the field choice percents relative to later years, especially for women.

being 20 percent and for females 17 percent. Again, the increase in the female percent of quantitative M.A. degrees is primarily attributable to increases in the percent of M.A. degrees that go to women, not to changes in their field choices. Across the decade the decline in the percent choosing quantitative M.A. fields was not much lower for women than for men.

At the *Ph.D. level* (Table 30), in 1979/80 a third of all students chose quantitative fields, as opposed to 45 percent in 1969/70--a decline of 27 percent. Both males and females chose these fields at lower rates, the decline for males across the decade being 17 percent and for females 23 percent. Thus, the increase in the female percent of quantitative Ph.D. degrees in the last decade is entirely attributable to the increase in the female percent of total Ph.D. degrees.

To assess *professional field* choice, the percents for 1969/70 should be ignored for the reasons described in the footnote to Table 31. From 1970/71 to 1979/80, about 4 out of every 10 professional degree students chose medical and other physically-/biologically-based fields. Although an increasing percent of the degrees in these field categories went to women from 1970/71 to 1979/80, the percents of women choosing these two categories *declined* noticeably across time. The percents of men choosing them either increased or declined only slightly.

In sum, the increased percents of women in quantitative fields at *all* degree levels are attributable to increases in the female percents at each degree level, not to changes in their field choices.

III. THE SCIENTIFIC/MATHEMATICAL TALENT POOL: EMERGENCE AND CHANGE

POLICY ISSUES

A cohort of specialists represents the survivors of an initially larger pool of individuals who initially pursued the specialty. A group's representation within a specialist cohort can be increased in two ways: (1) by increasing its share of the initial pool more than any increase in its attrition from it; and/or (2) by reducing its attrition from the pool by more than any decrease in its share of the initial pool. To affect either the size of the initial pool or attrition from it, policymakers have to know *when* to target and *what* to target. This section addresses the question of timing by examining the dynamics of the scientific talent pool. The next section addresses the substantive issue by identifying what drives people into and out of the pool.

Here we look at several questions: when does a pool of those with scientific interests first emerge in the educational pipeline? When does the pool seem to reach its maximum size? What are the rates of migration into and out of the pool as it moves through the pipeline? What relationships exist between scientific field interests and mathematical achievements at different points in the pipeline?

The definition of the term, "scientific/mathematical talent pool," changes according to the stage in educational pipeline. Prior to high school it consists of those individuals who express career interests that require at least college training in a quantitatively-based field. At this stage individuals who identify such career interests do not necessarily express college plans. During high school it consists of those whose career plans require at least a quantitative B.A. and who enroll in elective science and mathematics courses. At the conclusion of high school it consists of those who plan to attend college and to major in a quantitatively-based field.

During college the pool is defined to include those enrolled in a quantitatively-based major. Among college seniors or B.A. graduates it

consists of those who plan to attend graduate school in a quantitatively-based field; during graduate school, of those actually enrolled in such fields.

EMERGENCE OF THE SCIENTIFIC/MATHEMATICAL POOL

The scientific/mathematical pool first appears in elementary school. It emerges strongly prior to grade 9 and is essentially complete by grade 12. In a major study of the career development of scientists, Cooley (1963) found that by grade 5 (age 10) a *third* of those boys with above average intelligence had career interests that required at least a college degree in a quantitatively-based field.

Snelling and Boruch (1972) conducted a retrospective study of science B.A. graduates[1] from 49 select liberal arts colleges for the graduating classes of 1958-1967. They found that, depending on year: (1) over a *third* to a *half* of all science B.A. graduates had selected science as their major field of interest *prior to grade 9*;[2] (2) an additional 40 to 50 percent chose science as their major field of interest during grades 9, 10, and 11; and (3) grade 12 added only about another 5 percent. In sum, depending on the year, *89 to 95 percent* had selected science as their major field of interest by grade 12. Female science B.A. graduates tended to select science as their major field of interest somewhat later than their male [illegible] arts, but by grade 12 even 90 percent of the women had [illegible] science as their major field of interest.[3]

As we discuss in detail below, after grade 12 migration is almost entirely out of, not into, the talent pool. Thus, the pool from which quantitative Ph.D. students ultimately derive is essentially formed by the conclusion of high school.

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[1] Science B.A. degrees were defined to include all degrees in biology, chemistry, mathematics, physics, and premedicine.

[2] Across this 10-year period an increasing percent of those who ultimately obtained a science B.A. selected science as their major field of interest prior to grade 9.

[3] Although choice of science as the major field of interest [illegible]ently occurs early in the educational process, Snelling and Boruch found that over 50 percent of those who obtained science B.A. degree chose their specific college major during college, most of them during the first and second years of college.

The pool appears to reach its maximum size prior to senior high school, subsequently declining in size through graduate school. Cooley (1963) found that the quantitative career pool increased in size from grades 5 through 7. It appeared to reach its maximum at grade 7, declining in size in all subsequent years of junior and senior high school. At its height the pool approached 50 percent of the total sample, diminishing to about 25 percent by grade 12, with the major share of the decline occurring between grades 11 and 12.

The pool continues to decline in size after high school. It loses individuals from the pipeline itself and to non-science fields. Since, as we see below, migration is almost entirely out of, not into, the pool after high school, these losses are not replaced.

MIGRATION INTO AND OUT OF THE POOL

Although migration out of the pool during grades 9 to 12 is greater than migration into it, *migration into the pool does occur during these grades.* Cooley (1963) found that about half of those in the pool in grade 12 had entered during these grades. About half of the Snelling and Boruch sample of science graduates chose science as their major field of interest during these grades.

However, numerous studies show that *after high school migration almost entirely out of, not into, the pool.* In other words, the probability that an individual not in the pool at the end of high school will enter it during college or graduate school is close to zero. This irreversibility coincides with the conclusion of the high school mathematical sequence required for heavily quantitative college majors.

In a study of University of Rochester students, Cole (1958) found that 41 percent changed their majors during college. Among the changers, 54 percent migrated out of science and technology fields, 23 percent among science and technology fields, and only 3 percent from non-science to science and technology fields. Of 192 Project TALENT males in grade 12, Cooley (1963) found that only one had migrated *into* and stayed in a science major after high school, but that 30 or 16 percent had migrated out of science majors. Depending on the year, between 5 and 10 percent

of the Snelling and Boruch sample migrated into science as their major field of interest during college.

Using data from the *National Longitudinal Study of the High School Class of 1972*, Dunteman et al. (1979) analyzed the 1976 outcomes of those enrolled as college freshmen in 1972. As Table 32 shows, four years after college entry, only 3.4 percent of the males not originally enrolled in a science field had obtained a B.A. or were enrolled in a science field. The percent was lower for females (1.5 percent).

By 1976 those initially enrolled in a science major were less apt to have withdrawn from school without a B.A. degree than those originally enrolled in a non-science major. However, they were also less apt to have obtained a B.A. or be enrolled in their initial fields. Of those originally enrolled in a science field, only 37 percent of the males and 30 percent of the females had obtained a science B.A. or were enrolled in a science field by 1976. By this year 61 percent of the males and 64 percent of the females initially enrolled in a non-science field had obtained a non-science B.A. or were enrolled in a non-science field.

Just as freshman science and mathematics majors are almost the sole source of quantitative B.A. graduates, quantitative B.A. graduates are almost the only sources of quantitative Ph.D. graduates. Table 33 shows the undergraduate field "origin" for those 1980/81 GRE test-takers who *planned* to obtain quantitative Ph.D. degrees. These individuals came overwhelmingly from quantitative B.A. fields, especially those planning Ph.D. degrees in engineering and the physical sciences.[4]

National Science Foundation data on 1978/79 doctorates show about 80 percent of those who actually obtained doctorates in each of three quantitative fields (engineering, mathematics, and the physical sciences[5])

[4] Those with non-science B.A. degrees who plan a Ph.D. in the biological sciences come primarily from the health and applied biological fields. Those with non-science B.A. degrees who plan a Ph.D. in mathematics come primarily from other humanities and the social and behavioral sciences.

[5] The biological sciences are not discussed here because the data source subsumes these doctorates in a broad category of life sciences. The latter includes health fields.

TABLE 32

1976 STATUS OF 1972 COLLEGE FRESHMEN BY SEX AND FIELD[a]

	1972 Status	Total	Withdrew	Enrolled or B.A. in 1972 Field	Enrolled or B.A. in Different Field: Science	Enrolled or B.A. in Different Field: Non-Science	Unknown or Undecided
		1976 Status (Percent)					
Males	Science Major (N=1163)	100.0	[illegible].7	29.[illegible]	6.9	34.6	[illegible]
	Non-Science Major (N=2124)	100.0	32.2	55.9	3.5	15.2	3.3
Females	Science Major[b] (N=537)	100.0	21.9	23.5	[illegible].7	26.8	1.1
	Non-Science Major[c] (N=2638)	100.0	33.1	50.2	1.5	13.3	2.9

[a] Tables IV.3 and IV.4; George H. Dunteman et al., [illegible]. Research Triangle Park: Research Triangle Institute, 1979.

[b] Science Majors include majors in the physical sciences, engineering, mathematics, and the life sciences.

[c] Non-Science Majors include those who chose non-science fields and who in the fall 1972, had not yet selected a college major.

had B.A. degrees in the same field.[6] Although this percent is high and much higher than the percent for the non-quantitative doctorates, it appears to allow some in-migration. However, we do not know what percent of doctorates in each of these fields came from other quantitative fields. For example, among GRE test-takers who planned an engineering doctorate, 11 percent had B.A. degrees in mathematics and the physical sciences. Foreign citizens also earn large percents of

[6] Table 123, Department of Education, *Digest of Educational Statistics, 1981*, Government Printing Office, Washington, D.C.

Table 33

UNDERGRADUATE FIELD OF 1980/81 GRE TEST-TAKERS WHO EXPECT TO OBTAIN A QUANTITATIVE Ph.D.[a]

Undergraduate Field	Expected Ph.D. Field: Biological Sciences	Engineering	Mathematics	Physical Sciences
Quantitative Field	89.5	96.8	[illegible]	96.7
Non-Quantitative Field	9.0	2.1	10.0	2.2
No Response	1.5	1.1	1.7	1.1
Total	100.0	100.0	100.0	100.0

[a]Source: Table 32. Marlene B. Goodison, [illegible] Princeton: Educational Testing Service, 1982.

the quantitative doctorates.[7] We do not know how comparable undergraduate fields in foreign universities are to those in American universities.

Finally, using Project TALENT data, Wise et al. (1979) found that those in mathematically-oriented careers at age 29 came primarily from the scientific/mathematical pool in grade 12, i.e., from those who had mathematically-oriented career goals and dramatically higher mathematical achievement scores. Very few who had not planned a mathematically-related career in grade 12 had entered one by age 29. Those who switched into these careers had dramatically higher mathematical achievement scores in grade 12 than their counterparts who did not make this career change.

SCIENCE INTERESTS AND MATHEMATICAL SKILLS: EFFECTS ON MIGRATION

The issue here is how scientific and mathematical interests and abilities affect entry and retention in the pool. We raise this

[7] In 1978/79, foreign citizens earned almost half of the engineering doctorates, about a quarter of the mathematics Ph.D. degrees, and a fifth of the physical science doctorates.

question again in Section IV, but in relation to particular subgroups.

Entry and retention in the pool presumably indicate scientific and mathematical interests, but the role of scientific and mathematical abilities in this process is less obvious. What are the causal relationships between interests and abilities, and do these relationships change depending on the stages of the educational process? For example, as children begin to name non-stereotypic career interests in elementary school, are the mathematically most able most likely to select scientific careers? Or do science interests emerge independently of abilities? If so, do they remain independent of abilities, or do they trigger investments in science and mathematics courses that produce a pool whose members differ from non-members not only in their scientific interests, but also in their mathematical abilities?

Understanding how interests and abilities affect career choices and training investments at different points in the educational process gives policymakers a better basis for choosing among interventions that vary in their attention to career awareness versus mathematical skills. Although we do not know of studies that answer these questions adequately, certain data shed some light on them.

Prior to grade 9 students' career interests may be independent of their mathematical, verbal, and science achievements. This conclusion is offered tentatively: it depends primarily on Cooley's results, which may not be generalizable beyond his sample of primarily white males of above average intelligence.* At grade 8 Cooley found small achievement differences between boys whose career plans required college and those whose plans did not. However, for boys whose career plans required college, he found no achievement differences between those with non-science career plans and those with science career plans.

Although her sample was small and geographically non-representative, Jacobowitz's (1981) study of black eighth graders supports Cooley's

* For example, we might expect different results for a sample with greater variance in intelligence.

findings. She found that students' mathematical achievements at grade 9 were not related to their grade of preferences for science careers.[9]

Those with high mathematical achievement at grade 9 show increasing interest in quantitative careers from grades 9 to 12. In new analyses of Project TALENT data, Wise et al. (1979) found--both for male and female students--that during high school the pool of the mathematically able and the pool of those with quantitative career interests increasingly converged. In other words, by the end of high school members of the scientific/mathematical pool differed from non-members both in their career interests and mathematical abilities.

Available analyses do not tell us the processes by which this convergence occurs. In policy terms we see two important alternatives. One is that those with science interests before grade 9 produce the convergence by investing more effort in mathematics courses than those without such interests.[10] A second alternative is that those successful at the skills required to pursue scientific/mathematical interests are able to enter or stay in the scientific/mathematical interest pool, thereby gradually increasing the proportion of the pool that has high mathematical abilities.

Obviously, both processes may operate. However, if interests initially drive skills, and these in turn affect access to and retention in science training and careers, policymakers may want to consider interventions that stress early career exposure. If skills drive interests, either because we come to like what we do well or because we can only pursue interests that require skills that we possess, policymakers may want to consider early interventions that stress mathematical skills.

Whatever the process by which the scientific/mathematical interest

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[9] It should be noted that relative to white students, black students' occupational plans are generally less related to their abilities.

[10] As we discuss in Section IV, this hypothesis is consistent with the Wise et al. findings that: (1) grade 12 differences in mathematics achievements between those with equal achievements in grade 9 are attributable to different investments in high school mathematics courses; and (2) differences in course investments are attributable to different career interests.

and achievement pools converge, those with higher mathematical and verbal achievements plan more education than those with lower achievements. Table 34 shows that, for the high school senior classes of 1972 and 1980, as achievement increases, educational expectations increase. Among Graduate Record Examination (GRE) test-takers, those whose graduate objective is the Ph.D. have higher verbal and quantitative GRE scores than those whose objective is less than the Ph.D.[11]

Table 34

EDUCATIONAL EXPECTATIONS OF 1972 AND 1980 HIGH SCHOOL SENIORS BY LEVEL OF COMBINED VERBAL AND MATHEMA[illegible]

		Educational Expectation			
High School Class and Achievement Level	Total	No College	Some College	4-year or 5-year Degree	Graduate School
1972 High School Senior Class					
Low Achievement[b]	100.0	68.4	[illegible]	15.2	[illegible]
Middle Achievement[b]	100.0	[illegible]	15.5	34.2	8.0
High Achievement[b]	100.0	14.6	8.5	53.8	[illegible]
1980 High School Senior Class					
Low Achievement[b]	100.0	[illegible]	15.[illegible]	[illegible]	[illegible]
Middle Achievement[b]	100.0	39.4	15.4	[illegible]	[illegible]
High Achievement[b]	100.0	11.7	9.2	[illegible]	41.7

[a]Source: Department of Education, National Center for Educational Statistics. [illegible], 1981 Edition, U.S. Government Printing Office, Washington, D.C.

[b]The achievement index was based upon a composite score involving academic tests of vocabulary, reading, letter groups, and mathematics.

[11] For example in 1980/81, their combined verbal and quantitative GRE scores were, respectively, 1063 and 971 (Goodison, 1982).

Among those who plan more education, *those with higher mathematical achievements plan quantitative fields of study more frequently than those with lower achievements*. As Table 35 shows, among those who took the 1980/81 Scholastic Aptitude Test (SAT), their expected college majors follow this rank order of quantitative scores:

> physical sciences/mathematics/engineering/biological sciences > other humanities/behavioral sciences/health fields > arts/business and commerce/education.

Table 35

AVERAGE SCORES OF 1980/81 SAT TEST-TAKERS BY FIELD[a]
(N=994,[illegible]46)

	Total	Verbal	Quantitative
All Fields	890	424	466
Arts[b]	850	418	432
Other Humanities[c]	941	457	484
Education	809	391	418
Business and Commerce	844	398	446
Behavioral Sciences[d]	916	450	466
Health Fields	897	428	469
Biological Sciences	975	471	504
Engineering	980	446	534
Mathematics	1028	456	572
Physical Sciences	1056	498	558

[a]Source: College Entrance Examination Board, [illegible], Princeton: Educational Testing Service, 1981.

[b]Arts includes art, music, and theater majors.

[c]Other Humanities includes architecture, English, foreign language, philosophy, and religion majors.

[d]Behavioral Sciences includes geography, history and cultures, psychology, and social sciences.

Table 36 shows the quantitative scores of GRE test-takers in 1980/81 by field. The rank order of planned graduate fields by quantitative scores is *exactly* the same as the rank order of planned college majors. Again, those who expect to pursue quantitative fields at the graduate level have the highest scores.

In sum, before high school, among those whose interests require college, quantitative achievements may not differentiate those with science interests from those with non-science interests. However, by the end of high school higher quantitative achievements distinguish the science from the non-science group and affect the chances that a given student will complete a doctorate in a quantitative field.

Table 36

AVERAGE SCORES OF 1980/81 GRE TEST-TAKERS BY FIELD[a]
(N=198,768)

	Total	Verbal	Quantitative
All Fields	1005	485	520
Arts	974	493	481
Other Humanities	1039	530	509
Education	897	448	449
Behavioral Sciences	990	479	511
Health Fields[b]	988	484	504
Biological Sciences	1077	508	569
Engineering	[illegible]	449	655
Mathematics	1133	[illegible]	649
Physical Sciences	1156	511	645

[a] Table 66-67, Marlene B. [illegible] Princeton: Educational Testing Service, 1982.

[b] Health Fields includes fields such as [illegible], medicine, pathology, nursing, and public health.

SUMMARY AND CONCLUSIONS

The scientific/mathematical pool from which quantitative Ph.D. graduates ultimately derive first appears in elementary school. It emerges strongly prior to grade 9 and is essentially complete by grade 12. The pool appears to reach its maximum size prior to high school and subsequently declines in size through graduate school.

Although the talent pool seems to reach its maximum size prior to senior high school, migration into the pool continues to occur during grades 9-12. However, after high school migration is almost entirely out of, not into, the pool. As a consequence, those who obtain quantitative doctorates or have mathematically-oriented careers a decade after high school come overwhelmingly from the group who in grade 12 had scientific and mathematical career interests and high mathematical achievement scores.

Before grade 9 those who vary in the scientific orientation and postsecondary requirements of their career plans may not vary much in their mathematical, verbal, and science achievements. However, by grade 12 these achievements clearly differentiate those who plan college from those who do not and those who plan quantitative college majors from those who plan non-quantitative ones.

Among those planning graduate training, verbal and mathematical achievements continue to differentiate those who plan more rather than less graduate education. Mathematical achievements also continue to differentiate those who plan quantitative graduate degrees from those who plan non-quantitative graduate degrees.

These conclusions are often based on studies that used restricted samples--males only and/or whites only. Some of the major studies are old. However, we doubt that studies of minority groups would change these conclusions in any fundamental way. The high school and college preparation required to pursue a quantitatively-based doctorate is strongly hierarchical. These educational prerequisites would seem to allow less "room" for racially, ethnically, or sex-based behavioral variations.

This section has two major policy implications. First, strategies to increase the size of the initial scientific/mathematical pool of minorities and women should be targeted before and during high school. Second, strategies to decrease attrition from the pool can be targeted at any point in the process, in that attrition from the pipeline and from quantitative fields occurs at all points. We know little about minority attrition from the pool before college. However, Section II shows where postsecondary attrition from the pipeline or from quantitative fields is greatest for each subgroup.

IV. CAUSES OF MINORITY AND FEMALE UNDERREPRESENTATION AMONG QUANTITATIVE DOCTORATES

POLICY ISSUES

The representation of a subgroup among quantitative doctorates reflects the aggregate of individual decisions to enter and stay in the scientific/mathematical pool through the doctorate. Section III discussed the timing of these decisions, with their implications for when to target policy interventions. This section assesses their determinants, with their policy implications for whom (subgroups or their educational institutions) and what to target (e.g., skills, preferences, or financial resources). The challenges in this section are to: (1) separate the contribution of subgroup characteristics from institutional ones at different points in the pipeline; and (2) assess the influence of factors that organizations such as foundations might choose to affect. We discuss subgroups first and then educational institutions.

SUBGROUP CAUSES

We treat the subgroups as aggregates of individuals, not as actual groups in a sociological sense. Any individual decision, including the decision to enter the scientific/mathematical pool and the decision to stay in it, reflects specific instances of three factors: what the individual *wants* (preferences, motivations, values), *knows about* (information), and *can do* (resources, such as verbal and quantitative achievements, money).

To identify the nature and influence of the causes of entry and persistence requires a data base that:

- is longitudinal;
- measures individuals from late elementary school (certainly from grade 7), perhaps with an overlapping longitudinal design such as Project TALENT's;[1]

[1] For example, Project TALENT followed a grade 5 sample, grade 8 sample, and grade 11 sample, each for 5 years. This strategy created a design that overlapped at grades 8 and 9 and 11 and 12.

- substantially oversamples the groups in question to compensate for their small percent of the youth population (e.g., American Indians, Hispanic subgroups), their underrepresentation at the postsecondary level, or their underrepresentation among the quantitative disciplines;
- measures the individual variables just mentioned;
- and measures relevant characteristics of the educational institutions that individuals attend (e.g., high school availability of science and mathematics courses; college availability of financial aid).

Although data bases exist that meet some of these requirements, they all have age coverage and/or cell size problems. None of the more recent bases measures respondents before high school. All encounter cell size problems, especially among quantitative majors at the postsecondary level and especially for Hispanics and American Indians.

This section reflects the data situation. We can say much more about blacks and women than about the other subgroups, more about choices made in the high school senior year and in college than about those made in elementary, junior high, early high school, or graduate school, and more about capabilities and preferences than about information.

Causes of Women's Underrepresentation

Over the last 25 years analyses of women's choices of scientific training and careers have shown remarkably consistent results, and we consider only the most systematic analyses of the major data bases.

Initial entry into the pool. Wise et al. (1979) and Wise (1979) analyzed Project TALENT longitudinal data to assess the origins and career consequences of sex differences in high school mathematical achievement. They had measurements for grades 9 (1960) and 12 (1963) and for 3 points after high school (1964, 1968, and 1974). The data base is old, but their findings seem consistent with results based on more recent data. They found that:

- At grade 9 boys and girls did not differ significantly in mean levels of mathematical achievement. However, boys had average gains over twice as large as those of girls during high school, producing a large and statistically significant sex difference in mathematical achievement by grade 12.
- Virtually all of the sex difference in grade 12 mathematics scores could be explained by sex differences in elective high school mathematics courses.
- Participation in high school elective mathematics courses could be explained by grade 9 abilities in mathematics, educational aspirations, and interest in mathematics and mathematics-related careers. Sex differences in elective mathematics courses were primarily related to sex differences in interests.
- Men and women who by age 29 had successfully realized their grade 12 mathematically-related career goals had had dramatically higher mathematical achievement scores in grade 12. Very few who had not planned a mathematically-related career at grade 12 had entered one by age 29. However, those who switched into such careers had also had markedly higher mathematics scores in grade 12 than their counterparts who did not make this career change. This relationship persisted even when educational attainment and the mathematics level of the college major were controlled.

Persistence in the pool. Using data from the *National Longitudinal Study of the High School Class of 1972 (NLS 1972)*, Dunteman et al. (1979) found that the men and women who chose each of four "hard" sciences (physical sciences, engineering, mathematics, and life sciences) differed little from each other.[2] However, those who chose

[2] Although male and female hard science majors differed less from each other than these majors differed from all others, some sex differences did exist among the hard science majors. Relative to men, women had less high school mathematics and science preparation, higher high school grades, perceived their mother's educational aspirations for them as lower, and were more person-oriented.

these fields differed substantially from those who chose the social sciences and non-sciences. They had higher mathematics achievement, more high school mathematics courses, an orientation towards things rather than people,[3] and higher mother's aspirations for their educational attainment.

As Table 37 shows, these four variables strongly affect the probability of choosing a college science major for white males and females. For example, females medium in perceived mother's aspirations and low on science semesters, mathematics score, and orientation to things, had a 2 percent chance of choosing a science major. If they were high on these last three variables, their chances increased to 43 percent.

Table 37

PROBABILITIES OF CHOOSING A FRESHMAN SCIENCE MAJOR FOR NLS 1972 COLLEGE ENROLLEES[a]

Sex	Race	Sciences Semesters	Math Score	Thing Orientation	Mother's Educational Aspirations	Sample Size	Estimated Probability
Male	White	Low	Low	Low	Medium	79	.05
Female	White	Low	Low	Low	Medium	280	.02
Male	White	High	High	High	Medium	352	.53
Female	White	High	High	High	Medium	119	.43

[a]Source: Table V.16. George H. Dunteman et al., [illegible] Research Triangle Park: Research Triangle Institute, 1979.

Since women were more apt to be low on all four variables than men, these variables accounted for some of the differences between men's and women's probabilities of choosing a science major in 1972. However, as

[3] People orientation was a two-item composite, one item being a preference for jobs where the respondent can be helpful to others and the other a desire to work with people rather than things. Thing orientation was defined as a low score on this composite.

Table 37 indicates, even when women and men were statistically equated with each other on these variables, women were 10 percent less likely to choose a science major then men. In other words, even when women and men had the same mathematics achievement, orientation to things, number of high school science courses, and perceived mother's educational aspirations for them, women were still less likely than men to choose a science major. The authors could not eliminate the negative effect of being female on choice of a college science major, although they introduced several other plausible variables into the model, such as orientation to community, orientation to family, and future plans for family formation.[6]

Finally, Dunteman et al. found that persistence in a science major (1976) was strongly related to having chosen a science major in 1972. The variables that affected the 1972 choice had only minor effects on the 1976 science status. Being female also had little effect independent of its effect on the initial choice. In 1976 women were only 4 percent less likely than comparable men to be in a science major.

Summary. The Wise et al. (1979), Wise (1979), and Dunteman et al. (1979) analyses show a clear pattern.

1. Although grade 9 boys and girls do not differ significantly in average mathematical achievement, grade 9 girls like mathematics less and are less apt to choose mathematically-related careers than grade 9 boys.
2. Preferences for quantitative careers substantially increase participation in high school elective mathematics courses.
3. Participation in these electives strongly affects grade 12 mathematics achievement scores.

[6] We cannot tell if they tested for the effects of career plans, a variable that Wise et al. (1979) found to precede women's investments in mathematics and science. However, the person/thing dimension probably measures the dimension of career plans that is especially relevant to choosing a science major.

4. Mathematics ability and variables that seem to reflect earlier career interests--an orientation to things and number of high school science courses--strongly predict men's and women's choices of a science major in college.
5. These same variables and the initial choice of a science major strongly predict persistence in a science major.
6. High mathematical achievement at grade 12 predicts realization at age 29 of quantitative career plans at grade 12.
7. Those who at grade 12 had not planned a quantitative career and switched into a quantitative career by age 29 had high mathematical achievement at grade 12.

The key for women is pre-high school interests. These trigger an educational sequence that ultimately results in their underrepresentation among quantitative doctorates. These studies do not shed light on how girls' preferences are formed and therefore give us no basis for estimating what effects foundation-stimulated interventions might have on preferences. However, they do show that a strong preparation in mathematics in high school preserves the options of entering a college science major and a post-college quantitative career. Ironically, the high school tradition of offering more advanced mathematics as electives interacts with women's lesser interests in mathematically-related activities to foreclose these options to them. Removing choice during high school would preserve it after high school.

Trends in causal variables. We conclude our discussion of women by examining trends in some of the variables that affect women's pursuit of quantitative fields, e.g., participation in mathematics and science high school courses. Table 38 shows that male and female SAT test-takers have increased their average number of years of mathematics and physical sciences from 1973-1981, that males take a higher average number of years in both subjects than females, and that the difference between men and women in the number of course years has declined across time in the physical sciences more than in mathematics.

Table 38

MEAN NUMBER OF YEARS OF STUDY IN HIGH SCHOOL IN DIFFERENT SUBJECTS BY SEX AND YEAR FOR SAT TEST-TAKERS[a]

	English		Mathematics		Biological Sciences		Physical Sciences	
Year	Male	Female	Male	Female	Male	Female	Male	Female
1973	3.95	3.98	3.54	3.14	1.35	1.36	1.72	1.23
1974	3.94	3.97	3.53	3.13	1.40	1.41	1.77	1.36
1975	3.94	3.96	3.55	3.15	1.44	1.45	1.79	1.44
1976	3.91	3.96	3.57	3.17	1.46	1.48	1.80	1.45
1977	3.92	3.97	3.57	3.19	1.40	1.42	1.91	1.50
1978	3.93	3.98	3.60	3.22	1.38	1.40	1.97	1.53
1979	3.94	3.99	3.62	3.27	1.39	1.41	1.95	1.56
1980	3.93	3.99	3.65	3.32	1.39	1.41	1.99	1.57
1981	3.95	4.00	3.68	3.38	1.39	1.41	2.01	1.59

Source: College Entrance Examination Board, [illegible] series from [illegible] through 1981.

The National Assessment of Educational Progress (NAEP) and the SAT provide trend data on women's grade 12 mathematical achievement. The NAEP shows declines in males' and females' mathematics and science achievement, higher achievement in these subjects by males than by females, and no reduction in the sex differences of scores across time (Table 39). For the last decade both sexes of SAT test-takers have shown declines in verbal and mathematical scores, male SAT test-takers have had higher average verbal and quantitative SAT scores than women, the difference between their average quantitative scores is about 5 times the difference between their average verbal scores, and the difference is not diminishing across time (Table 40).

Table 39

TRENDS IN READING, MATHEMATICS, AND SCIENCE ACHIEVEMENT OF 17 YEAR OLDS BY SEX (1970-1980)[a]

Subject	Year	Males	Females
Reading	1971	67.2	70.7
	1975	67.2	70.6
	1980	66.9	69.7
Mathematics	1973	53.8	49.7
	1978	49.9	46.4
Science	1973	51.9	45.1
	1977	49.7	43.3

[a]Sources: National Achievement for Educational Progress, [illegible], Report No. 11-R-01, 1981; [illegible], Report No. 09-MA-21, 1980; [illegible], Report No. 08-S-21, 1979.

Table 40

DIFFERENCE BETWEEN MEAN MALE AND FEMALE SAT SCORES BY YEAR[a]

Year	Difference in Mean SAT Verbal Scores (Male-Female)	Difference in Mean SAT Quantitative Scores (Male-Female)
1972	2	44
1973	3	42
1974	5	42
1975	6	46
1976	3	51
1977	4	52
1978	8	50
1979	8	50
1980	8	48
1981	12	[illegible]
1982	10	50

[a]Source: College Entrance Examination Board. [illegible] series from 1972 through 1982.

Table 41

PERCENT OF HIGH SCHOOL SENIOR SAT TEST-TAKERS AND OF COLLEGE FRESHMEN[a] WHO PLAN A QUANTITATIVE MAJOR[b] BY SEX AND YEAR (1973-1981)

	SAT Test-Takers[c]		College Freshmen[d]	
Year	Men	Women	Men	Women
1973	36.0	15.0	26.3	9.1
1975	31.5	11.8	26.2	9.2
1977	29.6	9.8	27.5	9.2
1979	31.7	10.8	29.5	9.6
1981	35.7	13.2	32.6	11.6

[a] College freshmen are defined as fulltime, first-time freshmen.

[b] Quantitative Majors include biological sciences, computer sciences, engineering, mathematics, and physical sciences.

[c] Source: College Entrance Examination Board, *National College-Bound Seniors*, 1973, 1977, and 1981.

[d] Cooperative Institutional Research Program at the University of California at Los Angeles. *The American Freshman: National Norms* series for 1973, 1975, 1977, 1979, and 1981.

Table 42

PERCENT FEMALE OF SCIENCE AND ENGINEERING OCCUPATIONS IN 1972 AND 1980[a]

	Percent Female	
Occupation	1972	1980
Computer specialists	16.8	25.7
Engineers	0.8	4.0
Life and physical scientists	10.0	20.3
Chemists	10.1	20.3
Social scientists	21.3	36.0

[a] Source: Table 675. U.S. Bureau of the Census, *Statistical Abstract of the United States: 1981* (102nd edition), Washington, D.C., 1981, p. 402.

Table 41 shows that neither sex of SAT test-takers shows much shift from 1973 to 1981 in the percent who expect to major in a quantitative field. The female percents remain about a third of the male percents. Table 41 also shows that both male and female college freshmen show some increase in the percent selecting quantitative majors, but the female percent still remains about a third of the male percent.

Finally, we can look at changes from 1972 to 1980 in the percent female of selected quantitative professional occupations (Table 42). Although the hard science professions are still dominated by men, they are decreasingly so. College women's field choices do not yet register these labor market changes. However, to the extent that their choices are shaped by perceived labor market opportunities for women, they should begin to change The findings of Wise et al. (1979) suggest that a change toward quantitative career plans should trigger increased investment in high school mathematics and science.

Causes of Minority Underrepresentation

No existing longitudinal data base adequately samples any minority group at the life stages required to assess the origins and consequences of students' educational and career choices.[5] The *NLS 1972* has an adequate sample of blacks, but the survey's baseline measurement is grade 12, meaning that we cannot trace the process by which minority groups arrived at high school curricular choices and post-high school choices.

Minorities' choice of college major. Later in this section we report *NLS 1972* analyses of blacks' choices among and retention in college majors. To shed some light on causes of the underrepresentation of other minority groups, we conducted limited, exploratory analyses of survey data on 1981 fulltime, first-time college freshmen. Conducted by

[5] *High School and Beyond*, a longitudinal data base that adequately samples blacks and Hispanics, starts measurement at grade 10. However, baseline measurement was 1980, and the data base does not yet cover enough years to assess causes of postsecondary choices.

the Cooperative Institutional Research Program (CIRP) at the University of California at Los Angeles and the American Council on Education, this annual survey has very large sample sizes,[6] insuring adequate minority group samples. The sampling design is a two-stage design, the first stage being a sample of all American institutions of higher education, stratified by type (two-year, four-year, or university), selectivity of the student body (as measured by the average combined SAT verbal and mathematical scores of the institution's students), governance (public, private), and predominant race of the student body (white, black).

We wanted our analysis to illuminate why racial and ethnic groups varied in their choices of quantitative college majors. The causal possibilities that we examined included racial and ethnic origin, being second rather than first generation college, scholastic ability, educational plans, and characteristics of the postsecondary institution at which the student was enrolled.

Our major interest was in assessing the effect of parental education, defined as the highest educational level attained by either parent. Parental education is frequently one component of measures of family socioeconomic status. However, we were interested in it, not as some partial measure of family SES, but as an indicator of whether the student was first or second generation college.[7] Information on the dynamics of the scientific/mathematical pool and on the causes of women's underrepresentation identify early college tracking and an early orientation toward quantitative careers and training as important precursors of college entry and choice of a quantitative college major.

In light of these precursors, we hypothesized that being at least second generation college might be key to equalizing disciplinary choices among the racial and ethnic subgroups. Our reasoning follows.

[6] For example, the *unweighted* 1981 sample size for our analyses was 246,800 students.

[7] The student was defined as second generation college if either parent had completed even one year of college. Since we had educational data on the freshman's parents only, we could not determine if the student was more than second generation college.

(1) *Early college tracking.* Parents with any college are more likely to assume that their children will attend college, and the children of such parents are accordingly more likely to assume early in their schooling that they will go to college.

(2) *Required pre-collegiate training.* Parents with college know more about the early training investments that children must make to enter college and to pursue career interests, especially scientific/ mathematical interests. Pre-collegiate students plan their education far less than school requirements, parents, and teachers plan it for them.

(3) *Quantitative career options.* Second generation college students are more likely to have grown up with the wider occupational horizons available to the white collar mainstream. Movement from socially marginal positions, whether lower class white or minority group, into the mainstream *appears* to occur via a limited set of occupations. Groups have varied in the nature of their "tickets out." For example, the Irish used public sector jobs (e.g., police forces); blacks, the military, teaching, the ministry, entertainment, and athletics; Jews, entertainment, business, and the professions. If the "tickets out" for a particular group do not happen to include quantitative occupations, the generation that makes the move will show up less in these occupations--or in training for these occupations. First generation college students are more likely to be the generation that moves into the white collar mainstream. Second generation college students are more likely to come from families that have already made this move. These students should have grown up with the wider set of career options associated with the mainstream position secured by their ancestors.

On the basis of this argument, we postulated the model portrayed in Figure 1. Our central hypothesis was that second generation college substantially equalizes the percent choosing quantitative majors, across the non-Asian-American subgroups.

For administrative and cost reasons we could not estimate the full model with multivariate regression techniques. However, we could deter-

mine if the model seemed promising with three-way cross-tabulations. The major disadvantage of this technique is that we can only estimate the effect of a variable on college major choice, net of the effect of one other independent variable.[8]

Analyses of the 1981 fulltime, first-time freshmen confirmed the relationships hypothesized in Figure 1. For example, as Table 43 shows, being a non-Asian-American minority reduces the probability of being second generation college, high school grade average, university attendance, and choice of a quantitative major.[9]

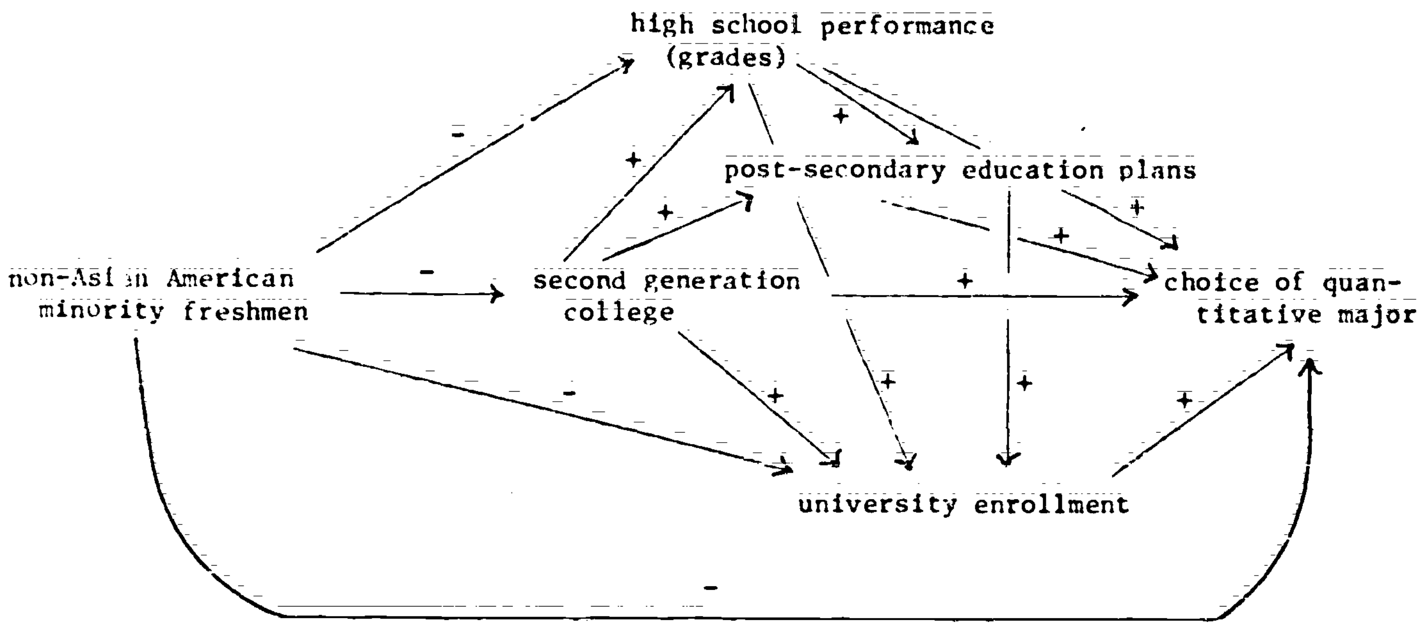

Figure 1. MODEL OF MINORITY CHOICE OF QUANTITATIVE MAJOR

[8] For example, we can estimate the effect of institutional type on quantitative major choice, net of parental education, but not net of parental education and high school grades.

[9] The literature shows that relative to whites of the same socioeconomic status, blacks have higher educational expectations. We therefore hypothesized no relationship between being a non-Asian-American minority and educational plans Table 43 shows that in fact there is a *positive* relationship between minority status and educational expectations for all minority groups.

Table 43

RELATIONSHIP BETWEEN RACIAL AND ETHNIC GROUPS AND MODEL VARIABLES (PERCENT)

Racial and Ethnic Group	Second Generation College	B+ High School Grade Average	Post-Graduate Degree Plans	Enrollment by Type of Institution: Two-Year College	Four-Year College	University	Percent Choosing Quantitative Major
White	67.1	47.8	56.3	35.6	39.1	25.3	20.3
Black	42.7	25.6	62.8	34.9[a]	49.6[a]	15.5[a]	15.3
American Indian	57.4	38.5	58.5	31.2	52.2	16.6	16.2
Chicano	38.6	37.0	59.5	27.7	49.6	22.7	17.4
Puerto Rican	41.5	33.9	56.3	37.8	47.2	15.0	14.9
Asian American	70.3	63.7	75.8	13.8	38.2	48.0	40.3

[a] In 1981, 42.4 percent of black freshmen attended predominantly black two-year colleges, four-year colleges, and universities. About 45 percent of these were enrolled in predominantly black two-year colleges and most of the rest in four-year colleges.

Table 44 presents the data required to test the hypothesized effect of parental education on choice of college major. The data confirm our hypothesis. *Being second generation college not only increases, but also equalizes, choice of quantitative majors across the white, black, American Indian, Chicano, and Puerto Rican subgroups.* When we disaggregate "first generation" and "second generation" college into six levels of parental education,[18] we find that the equalization among non-Asian-American subgroups occurs when parental education shifts from no college to *any* college. (The percent choosing a quantitative major increases as the amount of college that parents have increases, but the

[18] These six levels were: less than eighth grade, some high school, high school graduate, some college, college graduate, and some graduate school/graduate degree.

Table 44

PERCENT OF FIRST AND SECOND GENERATION 1981 COLLEGE FRESHMEN CHOOSING QUANTITATIVE COLLEGE MAJORS BY RACE AND ETHNICITY

	Percent Quantitative Majors	
Racial and Ethnic Group	First Generation College Freshmen	Second Generation College Freshmen
White	17.2	21.8
Black	12.0	19.5
American Indian	12.9	19.0
Chicano	15.2	20.8
Puerto Rican	12.1	22.0
Asian American	41.2	40.2
All	16.7	21.9

increase is approximately the same for all non-Asian American subgroups.

As Table 44 also shows, parental education does not affect college major choice of Asian-American freshmen. Although we had not expected parental education to *equalize* Asian-American and white freshman major choices, we had not predicted that this group's choices would be *insensitive* to variations in parental education.

The analyses show that parental education affects choice of a quantitative major through its effects on high school performance and postsecondary educational plans. However, our exploratory analyses do not tell us if parental education has an effect on the choice of college major in addition to its effects on these intervening variables.[11] If it does, the success of policies to increase minority representation among quantitative majors will be limited by parental educational

[11] The nature of the data base also precludes tests of the effects of other plausible intervening variables, such as junior high school interests, investments in high school mathematics courses.

attainments. Even if parental education does not have an independent effect, the success of policies targeted on the intervening factors still depends on how much these factors can be changed independent of changes in parental education.

The different non-Asian-American minorities seem to behave similarly with regard to choice of college major. As their families assimilate into the white collar mainstream, indicated by the presence of at least one parent with college, they behave like white college freshmen. However, the Asian-Americans do not behave either like other minority groups or like whites. They choose quantitative majors at double the white rates, and their choices are insensitive to variations in parental education. Like the other groups their high school performance and postsecondary educational plans increase as parental education increases, and their choice of quantitative majors increases as high school performance and postsecondary educational plans increase. However, each level of parental education translates into higher high school grades and postsecondary educational expectations for the Asian-American than for the other freshmen groups. Each level of high school performances and expected educational attainment also translates into higher rates of choosing quantitative majors.

Asian-American college freshmen are clearly high achievers from high achieving families. They have the highest percent of second generation college--a third, for example, have at least one parent with graduate education; the highest average high school performance (B+); and the highest average educational expectations--three-quarters plan a postgraduate degree. They concentrate in four year colleges and universities, especially in universities, and in the most selective colleges and universities. For example, 48 percent attend universities, and of those 60 percent are in the most selective universities. Thus, almost a third of all Asian-Americans in postsecondary institutions are in the nation's most selective universities, and another 13 percent are in the nation's most selective four-year colleges.

However, even when these impressive achievements and aspirations are taken into account, Asian-American college students still choose

quantitative majors at much higher rates than any other group. We can only speculate about the reasons for these quantitative preferences. Their quantitative strengths have long been noted in educational circles (e.g., Lesser, et al., 1964), but the nature/nurture debate triggered by this observation has by no means been resolved. A sociological possibility is the following. The Asian-Americans clearly come from cultures with high achievement drives, which for immigrant families should translate into concerted attempts to move up in the status structure of their adopted home. This home is Western with Western languages. The Asian-American skill advantage should therefore be quantitative rather than verbal. In their attempts to move into the white collar mainstream Asian-Americans have also faced substantial discrimination. The technical and scientific occupations should be freer of discrimination than those managerial and sales careers outside of the limited world of ethnic businesses.

In anticipation of our later discussion of institutional effects, we briefly note that choice of a quantitative major varies substantially by type of institution for all 1981 freshmen subgroups (Table 45). Universities have the highest rates of quantitative major choices for all subgroups. Two-year colleges depress these choices for the non-Asian-American minorities. Sectarian (Protestant and Catholic) four-year colleges depress them for whites, Chicanos, Puerto Ricans, and Asian-Americans. The blacks in predominantly black colleges and universities (42 percent of all black college freshmen) choose quantitative majors at the same rate as in predominantly white four-year colleges.

We cannot plausibly interpret these initial variations as institutional effects. CIRP data are collected in the fall of the freshman year, often during registration or orientation week. Although institutions may affect retention in school and retention in the initially selected major, it is hard to see how they could have much chance to affect initial choice. These initial variations would seem to reflect self-selection bias, institutional effects entering only in the sense that students tend to select schools whose quality standards and curri-

Table 45

PERCENT OF FRESHMEN CHOOSING QUANTITATIVE MAJORS BY INSTITUTIONAL TYPE AND RACE AND ETHNICITY

Racial and Ethnic Group	Two-Year Colleges	Four-Year Colleges							Universities						Predominantly Black Colleges		
			Governance			Selectivity				Governance		Selectivity				Governance	
	Total	Total	Public	Private Non-Sectarian	Private Sectarian	Low	Medium	High	Total	Public	Private	Low	Medium	High	Total	Public	Private
White	17.6	17.9	19.1	20.1	12.8	13.6	14.4	37.0	27.6	27.3	29.5	22.3	29.1	32.9			
Black	9.7	14.5	13.7	19.4	13.1	10.6	12.6	32.8	25.2	24.7	28.1	20.4	27.8	31.8	14.5	13.4	21.0
American Indian	8.6	15.3	14.1	19.5	16.1	13.2	12.5	38.1	28.3	27.9	30.1	31.4	24.7	31.2			
Chicano	10.6	15.4	16.2	16.6	12.5	11.1	14.2	50.1	26.6	26.1	28.2	20.8	18.4	30.4			
Puerto Rican	12.0	14.9	13.6	22.8	10.4	8.4	7.9	26.9	29.8	26.3	34.7	27.2	28.9	33.1			
Asian American	34.0	36.3	37.3	35.4	22.6	17.9	28.3	52.7	46.7	46.0	49.0	36.1	45.6	50.7			
Total	17.2	17.8	18.8	20.3	12.9	13.4	14.5	37.3	28.1	27.6	30.2	22.4	29.2	34.4			

cular strengths match their abilities and field interests.[12] [13] Thus, to isolate the effects of institutions on the production of quantitative B.A. graduates, it is important to eliminate variations in the skills and preferences that students attracted to different kinds of schools bring with them.

Although institutional types vary in their percents of quantitative major choices, there is more homogeneity among the non-Asian-American subgroups within each type. This greater homogeneity is consistent with the idea that the nation's freshmen sort themselves into institutions that fit their talents and interests. We see the greatest homogeneity for private, non-sectarian four-year colleges and for universities (public and private). These two institutional types have the highest percents of second generation college freshmen for all subgroups, a student characteristic already shown to equalize quantitative choices.

Blacks' choice of and retention in quantitative college majors. The CIRP data let us examine choice of, but not retention in, a quantitative college major. As we noted earlier, the *NLS 1972* adequately sampled black high school seniors, and Dunteman et al. (1979) used these longitudinal data to analyze 1972 black college students' choice of and persistence in a science major. Retention was defined as having obtained a science B.A. or as still being enrolled in a science major four years after college entry.

The authors used the same variables that they used to assess women's choices, but the relationships among the variables differed for the two groups. For blacks they found that:

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[12] For example, Venti and Wise (1982) report that measured academic aptitude and high school performance affect student choices of colleges more than college choices of students.

[13] The low rates of quantitative major choices in the sectarian four-year colleges are consistent with this match idea. The curricular strength of Catholic four-year colleges often lies in the humanities. Protestant colleges are usually small and therefore less able to afford the capital investment required for quality science education. Students with quantitative interests should therefore be less likely to select either of these kinds of colleges.

- Whereas family socioeconomic status (SES) plays no role for women, it affects black rates of choosing college science majors. Higher family SES is associated with higher rates of choosing science majors, and the family SES of 1972 black college freshmen was a full standard deviation below that of their white counterparts in college. The negative effect operated by reducing the mother's educational aspirations for the respondent (as perceived by the respondent) and high school mathematical achievement, both of which in turn affected the choice of a college science major.[14]
- Even when family SES is controlled, blacks are less oriented to things than whites, score over a standard deviation below whites in mathematical achievement, and take fewer high school science courses.
- Although lower family SES reduced mother's aspirations, when whites and blacks are equated on family SES, blacks have *higher* perceived mother's educational aspirations than whites.
- Being black has a negative, aggregate effect on choosing a science major in 1972 through the effects of race on an orientation to things, mathematical ability, and number of high school science courses. However, *when the two races are equated on the intervening variables, blacks have a higher probability of choosing a science major than whites.*
- The probability of being a 1976 science major or B.A. is primarily a function of major status in 1972. The four intervening variables continue to affect persistence in science, but have less influence later in college than in the freshman year.

Trends in causal variables. Section III showed that quantitative Ph.D. graduates derive almost entirely from the pool of quantitative

[14] Family SES includes parental education, and the Dunteman et al. results are consistent with our findings for the CIRP data for all non-Asian American minorities.

B.A. graduates. Analyses of the CIRP and *NLS 1972* data show that minority choice and persistence in the B.A. science track reflect parental education, career preferences, high school academic performance (especially in mathematics), and high school science preparation. Here we look briefly at the current status of the different minority groups on two of these factors: parental education and academic (especially mathematical) performance.

Table 46 shows the college attainment rates of 35-44 year old white, black, and Hispanic men and women for 1969-1989. The 35-44 year old age group is the age group whose children begin to enter college. The percents in Table 46 refer to all who have > 1 year of college at the interview date, the 1989 rates being based on the rates for those 25-34 years of age in 1979.

Table 46

PERCENT OF 35--44 YEAR OLDS WITH ONE OR MORE YEARS OF COLLEGE BY SEX, RACE, ETHNICITY, AND YEAR

	Males			Females		
Year	White	Black	Hispanic	White	Black	Hispanic
1969[a]	30.3	10.0	17.6	19.9	10.9	11.0
1979	42.1	24.9	19.1	30.7	20.0	12.2
1989[b]	52.7	31.2	27.5	41.4	31.3	19.1

Sources: U.S. Bureau of the Census, Current Population Reports, Series P-20, No. 194, [illegible], Washington, D.C., U.S. Government Printing Office, 1970. U.S. Bureau of the Census, Census of the Population: 1970. Subject Reports PC(2)-5B. [illegible], Washington, D.C., U.S. Government Printing Office, 1973; U.S. Bureau of the Census, Current Population Reports, Series P-20, No. 356, [illegible], Washington, D.C., U.S. Government Printing Office, 1980.

[a]The data for Hispanics is from the 1970 Census, not the 1969 Current Population Report on educational attainment.

[b]Rates for 35-44 year olds in 1989 are based on the rates in 1979 for 25-34 year olds.

Table 47

STANDARDIZED SCORES ON ASSESSMENT AREAS AND SOCIOECONOMIC STATUS OF SECONDARY SCHOOL SENIORS, BY RACIAL/ETHNIC GROUP: SPRING 1980[a]

Subject	Total	White	Black	Hispanic Ethnicity: All Hispanic	Mexican	Puerto Rican	Cuban	Other Hispanic	Asian-American	American Indian
	Standardized Scores[b]									
Vocabulary part 1	50.0	51.4	43.6	44.8	44.5	44.3	48.5	44.8	50.2	45.8
Vocabulary part 2	50.0	51.3	43.9	45.2	44.8	45.4	48.3	45.2	50.5	46.6
Reading	50.0	51.5	43.4	43.7	43.6	43.7	46.4	43.4	50.3	46.6
Math part 1	50.0	51.5	42.8	44.1	43.8	43.4	48.2	44.1	54.2	45.2
Math part 2	50.0	50.9	45.4	46.1	46.2	46.0	48.4	45.5	55.4	46.0
Mosaic Comparison part 1	50.0	50.9	44.4	48.0	47.9	50.0	49.7	47.5	52.4	49.3
Mosaic Comparison part 2	50.0	51.0	43.9	47.5	47.9	48.9	48.8	46.0	54.6	48.2
Three Dimensional Visualization	50.0	51.0	43.9	46.9	47.2	46.9	49.2	45.8	55.2	50.0
Socioeconomic status (SES) Composite[c]	50.0	51.2	45.1	45.7	44.9	41.9	47.6	48.1	51.9	47.8

[a]Source: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Study, unpublished tabulations.

[b]Scores are standardized to a mean of 50 points and a standard deviation of 10 points.

[c]Socioeconomic status (SES) composite computed from father's occupation, father's education, mother's education, family income, and a household item index.

All three groups show substantially increased rates of college attainment over the 20 year period, especially whites and blacks. The rates for both the men and women of these two groups increase 20 percentage points, reducing the ratio of white to black college attainment for men from 3:1 in 1969 to 1.7:1 in 1989 and for women from 2:1 in 1969 to 1.3:1 in 1989.

Hispanic rates do not show as large an increase; in fact, the ratio of white to Hispanic college attainment is unchanged for women across the 20-year period and increases slightly for men. However, the Hispanic rates should be interpreted very cautiously. As discussed earlier, the Hispanic subgroup experienced substantial in-migration during the 1970s, and this in-migration is expected to continue during the 1980s. The more recent waves of Hispanic immigrants have had less education. If length of residence in the United States is related to college attainment rates, the increase in these rates for longer-term Hispanic residents should be better than Table 46 indicates. For the same reason the estimate of 1989 rates has to be treated cautiously. If the group 25-34 years of age in 1979 acquires substantial numbers of less educated immigrants during this decade, the college attainment rates of that group will fall below the rates that are now projected for 1989.

Table 47 shows the standardized verbal and quantitative scores for 1980 high school seniors by race and ethnicity. On the mathematical tests the rank order of scores is: Asian-Americans > Whites > Cubans > American Indians > Puerto Ricans/Chicanos > Blacks.

Table 48 presents the SAT performance of blacks, whites, and Chicanos for 1977 and 1982. For whites both verbal and quantitative scores declined. However, the results for blacks and Chicanos are encouraging. On both SAT dimensions the performance of both groups improved, especially that of blacks. In only five years blacks have reduced the black-white difference from 120 to 103 points for SAT verbal scores and from 135 to 117 points for SAT quantitative scores. Increases in black scores account for more of the reduction in differences than declines in white scores.

Table 48

SCHOLASTIC APTITUDE TEST (SAT) SCORES FOR COLLEGE-BOUND SENIORS BY RACE AND ETHNICITY AND YEAR

Racial and Ethnic Group	Verbal		Mathematical	
	1977[a]	1982[b]	1977[a]	1982[b]
Whites	449	444	490	483
Blacks	329	341	355	366
Chicanos	374	379	412	416
Puerto Ricans	NA	360	NA	403
Asian-Americans	NA	390	NA	513

[a]Source: Robert L. Jacobsen, "Blacks Lag in SAT Scores," *The Chronicle of Higher Education*, January 7, 1980, Vol. 19, No. 16, p. 5.

[b]*Los Angeles Times*, Part I, October 14, 1982, p. 4.

In 1980/81 the average GRE scores of those who planned graduate study in the physical sciences, biosciences, mathematics, or engineering were 628, 569, 649, and 655, respectively. Since the standard deviation for each field was about 100 points, those who scored 100 points below the mean for a field scored below 84 percent of those planning graduate study in that field. A quantitative score of 550, for example, would be 100 points below the mean scores for mathematics and engineering. Table 49 shows that the percent of each group with quantitative scores at *or below* 550 was 39 percent for Asian-Americans, 56 percent for Whites, 72 percent for American Indians, 81 percent for Mexican-Americans. 85 percent for Puerto Ricans, and 93 percent for Blacks.

The data on GRE score distributions suggest that groups with lower scores may be selecting themselves out of fields with high average scores. We can check this possibility with the data in Tables 50 and 51, which, respectively, show the average SAT and GRE combined quantitative and verbal scores for the undergraduate or graduate fields that test-takers expect to enter.

Table 49

DISTRIBUTIONS OF GRE APTITUDE TEST QUANTITATIVE SCORES BY ETHNIC GROUP (U.S. Citizens Only)[a]

	PERCENT OF GROUP BELOW SCORE									
SCORE	AMERICAN INDIAN	BLACK/ AFROAMER	MEXICAN-AMERICAN	ORIENTAL OR ASIAN	PUERTO RICAN	OTH HISP LATIN-AM	WHITE	OTHER	NO RESPONSE	TOTAL
800*	99.5	100.0	100.0	98.3	100.0	99.7	99.2	99.3	98.8	99.3
750	98.4	99.8	99.3	92.6	99.7	98.7	96.1	95.7	94.9	96.3
700	94.4	99.4	97.9	81.5	98.4	95.7	90.0	88.2	87.7	90.6
650	90.7	98.5	94.6	65.4	95.6	90.0	81.[illegible]	80.4	78.5	82.7
600	83.0	96.6	89.1	53.8	91.2	81.4	73.1	68.4	66.2	71.9
550	72.0	93.1	81.4	38.5	84.5	71.5	56.0	54.1	52.5	58.6
500	59.8	87.3	70.8	26.5	74.0	58.4	40.7	39.1	39.6	44.2
450	46.2	78.4	58.4	15.7	59.7	45.2	26.1	25.5	26.5	30.1
400	32.9	64.8	43.8	8.9	43.9	31.3	14.4	15.3	16.4	18.4
350	19.6	49.4	31.1	5.2	29.7	18.7	7.2	8.5	9.8	10.5
300	10.4	30.4	15.5	1.8	16.5	9.7	2.7	3.8	4.6	4.8
250	4.2	13.8	6.0	0.4	7.5	3.5	0.7	1.2	1.8	1.7
200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N	1096	11133	2150	2940	1282	1437	148513	3339	6567	178457

*THEORETICAL MAXIMUM SCORE IS 900

[a]Source: Marlene B. Goodison, *A Summary of Data Collected from Graduate Record Examinations Test-Takers During 1980-81*. Princeton: Educational Testing Service, 1982.

Table 50

SAT TEST SCORES OF HIGH SCHOOL SENIORS BY RACIAL OR ETHNIC GROUP AND ANTICIPATED MAJOR IN COLLEGE[a]

	Mean Composite SAT				
	Whites	Blacks	Chicanos	Puerto Ricans	American Indians
Arts and Humanities	930	732	845	831	808
Education	884	63[illegible]	751	738	755
Social Sciences	1,029	735	866	796	839
Business	950	695	807	814	798
Allied Health Fields	958	710	846	800	868
Biological Sciences	1,066	807	921	897	855
Engineering	1,109	848	1,018	918	969
Physical Sciences and Mathematics	1,142	845	1,016	915	979

[a]Source: Alexander W. Astin. *Minorities in American Higher Education*; San Francisco: Jossey-Bass, 1982, p. 70.

Table 51

1980/81 COMBINED VERBAL AND QUANTITATIVE GRADUATE RECORD EXAMINATION (GRE) SCORES BY EXPECTED GRADUATE FIELD AND RACE AND ETHNICITY[a]

Expected Graduate Field	Total	White	Black	Mexican-American	Puerto Rican	American Indian	Asian-American
Total	1015	1039	733	847	801	925	1054
Arts	979	992	733	820	739	882	997
Other Humanities	1049	1064	774	851	784	969	1026
Education	900	929	661	751	718	808	92[illegible]
Behavioral Sciences	1030	1055	765	902	804	933	1054
Health Fields	995	1015	774	882	798	903	1032
Biological Sciences	1093	1110	822	1013	798	1001	1102
Engineering	1184	1202	964	1063	965	1111	1126
Mathematics	1182	1208	834	1044	923	[illegible]	1104
Physical Sciences	1162	1170	884	985	885	1140	1163

[a]Source: Marlene B. Goodison. *[illegible]*. Princeton: Educational Testing Service, May 1982, pp. 74-77 and pp. 79-80.

If we rank order the fields by their scores, we see essentially the same rank order of fields at the undergraduate and graduate levels and for each racial and ethnic group. However, the distribution of each racial and ethnic group among the more, less, and least "difficult" fields occurs relative to the distribution of talent *within the racial and ethnic group*, not within the total SAT or GRE population. If the field distribution for each subgroup occurred relative to the total population, we would see much less difference between the mean SAT or GRE scores for different subgroups in the same field than we see. For example, although each subgroup shows variation in scores across fields, for each field the average black score is about 70 or 75 percent of the white score.[15] In other words, having a smaller percent with high quantitative scores does not seem to limit a subgroup's choice of fields with high average scores as much as one might expect.

Summary and Conclusions

Available analyses indicate fundamentally different causes of women's and minorities' underrepresentation among quantitative doctorates. By grade 12 all underrepresented groups have smaller percents with the high levels of mathematical achievement associated with quantitative college majors. However, the factors that produce these lower percents differ by subgroup. For women they seem to be the familiar motivational factors that shift girls' interests away from sex atypical careers and the high school mathematical sequence associated with quantitative postsecondary training. During adolescence individuals are under simultaneous pressures to resolve sexual identities, form career preferences, and invest in any high school training required to pursue their preferences. Scientific career interests and investments in high school mathematics are consistent with the development of masculine, but not feminine, identities.

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[15] Although these data refer to college or graduate school aspirants, not graduates, we see the same score and field pattern by racial and ethnic groups for those who obtained B.A. degrees.

For the non-Asian-American minorities the major factors seem to be family socioeconomic status, especially parental education, with its: (1) demonstrated effects on educational aspirations and high school mathematical and science achievements, and (2) probable but undemonstrated early effects on career information and career preferences.

The nature of these causes implies that structural changes already underway in the society should gradually increase women's and minorities' representation among quantitative doctorates. As the society decreasingly defines achievement by women and social approval of them as conflicting, the association between masculinity and "hard" science careers breaks down, and families increasingly recognize the economic need for daughters to plan careers, more girls should choose careers that require quantitative training. We should also see them make these choices in time to take high school mathematics that are required to pursue them.

As minorities move increasingly into the white collar mainstream, at least their children's educational attainment and quantitative career choices should increase. The data reported in this paper suggest that changes in educational attainment will probably precede changes in field choices.

INSTITUTIONAL CAUSES

Introduction

The institutional question is easy to state. Independent of their students' characteristics at entry, how do different types of educational institutions affect their students' educational attainments, mathematical and science preparation, and postsecondary field of training?

The answers to this question matter to policymakers, parents, taxpayers, students, and the educational institutions themselves. Some of the nation's most heated educational debates resolve into questions about the effects of types of institutions on student outcomes. For example, relative to segregated schools, do desegregated elementary and

secondary schools increase student achievement? Do private versus public high schools increase student achievement? Do two-year colleges reduce their students' ultimate educational attainment? Do predominantly black colleges increase black students' educational attainment?

However, questions about institutions are not necessarily easy to answer because the interest is in how institutions affect student outcomes over and above what would have happened to students in any school. Astin (1973) stated this problem well almost 20 years ago.

> The importance of using rigorous research designs in attempting to compare the effects of different types of colleges on student performance is clearly illustrated by the history of the "Ph.D. productivity" problem. In the earliest studies it was found that undergraduate institutions differed markedly in the proportions of their graduates who eventually obtained Ph.D. degrees. Such differences were "explained" in terms of the college's characteristics: type of control, level of training of the faculty, geographical region, laboratory facilities, and so on. However, in subsequent studies it was found that these differences in the output of the Ph.D.'s could be attributed at least partially to the characteristics of the entering students, rather than wholly to the effects of the institutions themselves. Two recent studies have, in fact, shown that many of the institutions which were classified previously as "highly productive" turn out to be among the most "unproductive" when selected characteristics of their student inputs are controlled. (p. 137)

Our earlier discussion of how schools varied in their percents of freshmen who chose quantitative majors (Table 45) illustrated Astin's point. These initial differences could not realistically be attributed to the effect of the schools, although such initial differences presumably show up in differences between schools in their production of quantitative B.A. graduates.

Separating *institutional* effects from *compositional* effects (the effects of individual student characteristics) has turned out to require theoretical, measurement, and methodological sophistication. For example, the social sciences have encountered major problems just in identifying, properly conceiving of, and adequately measuring institu-

tional and student characteristics that affect ultimate outcomes. In the institutional case, for example, the research stimulated by the 1966 Coleman report on equality of educational opportunity is finding that schools in fact do differ somewhat in their effectiveness, as measured by student achievement. However, the relevant institutional characteristics are less those of easily measured inputs, such as buildings, than organizational and process variables that are difficult to define and costly to measure--for example, management autonomy at the level of the school, instructional leadership, staff stability, curriculum articulation and organization, school-wide staff development (Purkey and Smith, 1982).

On the student side, educational aspirations provide a case in point. At the start of college two groups of students may look identical on aspirations, but in fact have different "growth curves." One group's aspirations may be less realistic, as measured by factors that we know affect ultimate attainment regardless of school, e.g., ability. The group may also be less committed to those aspirations, e.g., more attracted to work. The lower ability and less committed set may choose a two-year college *precisely* because it presents less academic challenge and implies less commitment; the second set, a four-year college for exactly the opposite reasons. Even though both groups started with identical self-reports of their aspirations, we would expect more of the first set to drop out of school before attaining them than the second set, completely independent of the schools that they attended. Unless we conceive of and measure aspirations in ways that let us adequately detect initial differences, we run the risk of attributing outcome differences to differences between two- and four-year colleges, rather than to the nature of the students who chose them.

Reasonable Expectations: How Much Effect?

It is useful to ask how much differences among institutions might affect student outcomes. *In general* studies find that much, although not all, of the variation between schools is attributable to compositional, not institutional effects. For example, Alexander et al. (1979)

found that variations between high schools in the composition of their student bodies accounted for most of what had been identified in the literature as school effects on student college plans.

Using the *NLS 1972* data base, Anderson (1981) estimated the college attrition effects of experiences during college, net of differences in background characteristics. The experiences included college type (two-year and four-year), and her sample was restricted to students enrolled in the academic curricula of both kinds of schools. She found that a four-year college increased persistence by 5 percent from year 1 to year 1 and by 14 percent from year 2 to year 3.

Two factors accounted for some of the college effect. Relative to four-year college students, two-year college students are more apt to work longer hours in a regular (not work/study) job. Longer hours in such jobs reduced persistence. They also are more apt to live off-campus or at home, and these residential arrangements reduced persistence, especially if the student was working. We may or may not want to hold two- and four-year colleges "responsible" for these differences in their students' working and living arrangements.

In analyses of the career choices of over 6000 National Merit scholars, Astin (1973) found that for males certain types of colleges increased the probabilities of choosing a science career, net of entry characteristics. However, he concluded that the characteristics of high aptitude students at college entry appeared to be much more important than the characteristics of the colleges that they attended in determining final career choices.

These and many other empirical studies suggest that we should expect some, but limited, effects of institutions. Our empirical knowledge about human development indicates that we should expect more limited institutional effects at the postsecondary than at elementary and secondary levels. As the individual ages, outcomes are increasingly determined by characteristics that the individual brings to the situation, rather than by the situation itself. We also need to be more sensitive to the possibility of self-selection at the postsecondary level. Most families have more limited choices of elementary and

secondary schools than of colleges, and, as choices increase, the chances that self-selection will affect ultimate outcomes also increase.

Reasonable Expectations: What Kind of Effects?

Although institutional variations generally seem to have only limited effects on student outcomes, we can still ask what institutional characteristics might make a difference.

Briefly, let us review the facts to this point.

1. By the conclusion of high school only those already in the scientific/mathematical game have the option of continuing to play it.
2. Early college tracking, early scientific/mathematical interests, and substantial investment in junior and senior high school science and mathematics courses are precursors of post-high school entry into quantitative training and careers.
3. The underrepresentation of women in the quantitative disciplines seems traceable to early "feminine" career interests and their training consequences.
4. The underrepresentation of non-Asian minorities seems traceable to the negative consequences of lower family social status, especially parental education, on early college tracking, occupational horizons, and academic performance.

These facts indicate the importance of the earlier years of education and therefore of our elementary and secondary schools in any attempt to increase the representation of women and minorities in the quantitative disciplines. The task before the schools is to change the restricted horizons and achievement ultimately responsible for their underrepresentation. Our schools control the amount of time that students spend on different subjects, the quality of their curricula, and the performance standards for grade promotion and high school graduation. As studies clearly show, time-on-task does affect how much students learn, the quality of that time does affect how involved

students become in a subject, and standards do affect how hard students work and what courses they take.

Public elementary and secondary schools generally do not serve any children well in science and mathematics. The deficiencies matter most for those youth (girls and minorities) who do not have compensating resources and encouragement outside of the school. Let us look first at time-on-task. In elementary school students spend an average of 25 percent of their weekly instructional time on mathematics, but only 11 percent on science (Weiss, 1978). High schools vary substantially in the science and mathematics courses even offered. In 1977 at least 80 percent--but not all--of the nation's public high schools offered introductory mathematics and science courses (biology I, chemistry I, physics I, algebra I, and geometry I), but far fewer offered more advanced courses (trigonometry--54 percent; calculus--31 percent; biology II--47 percent; chemistry II--23 percent; physics II--5 percent) (*Condition of Education*, 1980). As a result only about a third of the nation's high school graduates complete three years of mathematics; only a fifth, three years of science (*Science and Mathematics in the Schools*, 1982).

It is hard to assess the quality of science and mathematics instruction. However, quality may be one explanation for what we observe in student attitudes toward science. Students' positive attitudes toward science instruction decline from over 50 percent in grade 3 to 20 percent in grade 8 (*Science and Mathematics in the Schools*, 1982). It is not known why the percent who like science is so low even by grade 3 and declines still further over the subsequent five years of schooling. Children are "natural" scientists--curious about the world around them. One factor may be that the overwhelming majority of elementary school teachers are women, who themselves are less apt to like or be competent in science. As a group, they may reinforce the handicaps that girls and minorities bring to science. Whatever the reason, schools fail to maintain, let alone augment, earlier positive attitudes toward science.

Finally, schools' performance standards define minimally acceptable

student work and, in high school, the courses required for graduation. We do not know what the quality standards are or how they vary across the grades. However, about 15 years ago high schools began to liberalize their graduation requirements. Today only a third of the nation's school districts require more than one year of mathematics and one year of science to graduate (*Science and Mathematics in the Schools*, (1982). Since those without the high school advanced mathematics/science sequence lose the option to play the quantitative game, our attempts to give students more choice in high school resulted in restricting their choices after high school.

Although schools may vary in how they distribute their science and mathematics resources between boys and girls *within* a school, girls are no more vulnerable than boys to resource variations between schools. This is probably not true for minorities. We do not know how mathematics and science resources distribute across schools with different racial and ethnic compositions. However, for various reasons we can probably safely assume that schools with predominantly minority enrollments have fewer such resources. If this is true, such distributional differences would affect a large percent of minority students. In 1978 60 percent of the nation's minorities who were enrolled in public elementary/secondary schools attended predominantly minority schools (50 to 100 percent minority enrollments).[16]

These data suggest that schools could increase students' mathematical and scientific skills and interests by increasing the required time-on-task and the quality of that instruction. Simply increasing the science and mathematical graduation course requirements would help protect students' future training and career options.[17] At the same time, it has to be recognized that unless school days are lengthened, more time on science and mathematics represents less time for other

[16] Thirty percent of minority students were enrolled in schools with 90-100 percent minority enrollment (*Condition of Education*, 1981).

[17] Some states, such as California and Florida, are considering increasing or have already increased their mathematics and science for high school graduation or state college entry.

subjects or activities. Increasing science and mathematics graduation requirements and the quality of that instruction also require more teachers and more qualified teachers. The schools already face shortages of mathematics and science teachers--in 1979, excluding the special education field, 40 of the public school field vacancies[18] fell into the mathematics and science fields (*Condition of Education*, 1981). They also face a decline in the quality of individuals who enter and stay in teaching (e.g., Dworkin, 1980; Vance and Schlechty, n.d.). Since high school mathematics and science teachers have more employment and attractive salary opportunities in industry than teachers in other fields,[19] experts expect the quality problem that affects the whole teaching profession to be worse in the mathematics and science fields (personal communication, Schlechty).

The major issues about the effects of postsecondary institutions on women's and minorities' representation in the quantitative disciplines are: (1) effects on college entry (financial costs, scholarship aid, and academic selectivity); (2) effects on educational attainment; and (3) effects on field of training.

The literature on postsecondary institutional effects is smaller and generally of lower quality than the literature on elementary and secondary institutional effects. However, the first issue (college entry) is much better researched than the second and third. The issues of college entry are more relevant to minorities than to women, especially the financial dimensions of the college-going decision. The econometric literature clearly shows that scholarship help increases college-going (e.g., Fuller, Manski, and Wise, 1982). However, the question is whether lack of aid prevents college entry (and retention) of those students who would otherwise obtain a quantitative degree. We do not know of studies that answer this specific question.

[18] These slots could not be filled for lack of qualified personnel, not because of budget constraints.

[19] For example, in the San Francisco area a new mathematics B.A. graduate can get a starting salary of about $13,000 in teaching and $20,000 in industry. The salary difference increases over time.

However, we do know that: (1) those who plan a quantitative college major and obtain a quantitative B.A. represent the most able members of their particular racial and ethnic subgroup; (2) more able high school graduates are more committed to postsecondary education, as indicated by their educational objectives; and (3) of those applicants who need financial help, the more able attract more scholarship aid (Venti and Wise, unpublished, reported in Fuller, Manski, and Wise, 1982). These relationships suggest that needy applicants who have the ability to select and stay in a quantitative major are also the most likely to seek out and receive adequate financial help.

As noted, very little is known about the effects of postsecondary institutions on educational attainment and field of training. Controlling on freshmen characteristics, Astin (1982) found that for those who expected to get at least a B.A. degree, entry into a *public* two-year college had a small, but statistically significant, negative effect on the college persistence of all racial and ethnic groups except Puerto Ricans. He did not find this effect for *private* two-year colleges. His results are consistent with those of Anderson (1982), discussed earlier.

For those students who expected to obtain at least a B.A. degree, Astin (1982) found that entry into traditionally black institutions also reduced persistence. This was true for both two-year and four-year traditionally black colleges.

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